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Tri-Set Training System Induces a High Muscle Swelling with Short Time Commitment in Resistance-Trained Subjects: A Cross-Over Study

JÚLIO B.B. DE CAMARGO[†1], RAFAEL S. ZARONI[*1], ANTÔNIO C.T. JÚNIOR[‡2], THIAGO P. DE OLIVEIRA[‡3,4,5], THIAGO B. TRINDADE[‡6], CHARLES R. LOPES[‡1], and FELIPE A. BRIGATTO[‡1]

[1]Methodist University of Piracicaba, Piracicaba, SP, BRAZIL; [2]Sao Paulo State University, Bauru, SP, BRAZIL; [3]"Julio de Mesquita Filho" State University, Rio Claro, SP, BRAZIL; [4]Anhanguera University Center, Leme, SP, BRAZIL; [5]Claretiano University Center, Rio Claro, SP, BRAZIL; [6]Catholic University of Brasilia, DF, BRAZIL

[†]Denotes graduate student author, [‡]Denotes professional author

ABSTRACT

International Journal of Exercise Science 15(3): 561-569, 2022. The purpose of the present study was to assess performance and morphological acute responses to the tri-set (TRI) resistance-training system. In a random order, 18 subjects (years: 30.0 ± 5.6; weight: 81.8 ± 13.4 kg; height: 173 ± 6.2 cm; RT experience: 4.6 ± 1.7 years) performed 3 exercises targeting the pectoralis major muscle in two different experimental conditions: traditional system (TRAD) and TRI. The TRAD protocol referred to the completion of a single exercise set followed by a rest period. For the TRI protocol, one set of each exercise was performed sequentially with a minimal rest interval afforded (< 10 seconds). Both protocols were performed in 3 sets of 10RM. Pectoralis major muscle swelling (PM_{MS}), volume load (VL), internal training load (ITL) and training efficiency (TE) were calculated and compared between both protocols. Despite the low VL (-19.3%; $p < 0.001$), larger values of PM_{MS} (104.7%; $p < 0.001$), ITL (24.3%; $p < 0.001$) and TE (56.0%; $p < 0.001$) were observed during TRI compared to TRAD condition. In conclusion, the adoption of a TRI training protocol may induce distinct performance and morphological acute responses compared to TRAD, suggesting that resistance-trained subjects may experience a higher muscle swelling and intensity of effort with short time commitment when performing TRI system.

KEYWORDS: Strength, advanced methods, thickness, efficiency

INTRODUCTION

Resistance training (RT) is an important component of exercise programs that induce relevant improvements in health, sports, and aesthetic-related parameters. Increases in muscle strength and mass are usually the two of the main adaptations observed during RT protocols (21).

In order to increment the acute/chronic RT-induced responses, coaches and practitioners usually manipulate training variables over a period of time. However, as one´s training level/experience increases, the magnitude of the adaptive responses tends to be reduced (2). In this sense, the adoption of some advanced training techniques has been shown to acutely increase the total work (sets x repetitions x load; i.e. volume load [VL]) performed by a given muscle group, as in the case of cluster sets (8,14) and agonist-antagonist supersets (19), which would lead participants to experience increased levels of mechanical tension, a factor that has been described as a relevant driver of RT-induced muscle hypertrophy (22). In addition, when disposing of a reduced available time to perform the training sessions, other advanced systems may be adopted in order to maximize the VL completed per unit of time (training efficiency [TE]). Agonist and antagonist supersets, for example, have been shown to be time-efficient systems, allowing participants to experience a higher TE compared to traditional protocols (19). Similarly, drop-set and sarcoplasma stimulating training, in addition to the increased values of TE, have been shown to induce higher acute muscle swelling ("pump") (3,15), which is associated with the activation of integrin, a membrane protein that triggers intracellular anabolic mechanisms, and reduces catabolic processes, accompanied by increased muscle protein synthesis (23,25).

The "Tri-set" method (TRI) is another advanced training technique that is usually adopted by experienced lifters. Briefly, it consists in performing three exercises consecutively followed by a recovery period (27). The only study to date that has acutely investigated the effects of TRI adopted exercises that targeted different muscle groups (27). However, highly experienced trained individuals commonly implement split routines, in which several exercises are performed for the same muscle groups within a training session (7). In this sense, to the best of our knowledge, no study has investigated the acute responses to TRI performed for the same muscle groups. Therefore, the aim of the present study was to assess the acute effects of TRI on performance and morphological parameters of resistance trained subjects. The initial hypothesis was that TRI would induce larger reductions in the total training volume performed and larger increases in muscle swelling compared to a traditional system.

METHODS

Participants

Eighteen resistance trained men (years: 30.0 ± 5.6; weight: 81.8 ± 13.4 kg; height: 173 ± 6.2 cm; RT experience: 4.6 ± 1.7 years; bench press exercise one repetition maximum [1RM]:112.4 ± 13.8 kg; relative strength for the bench press exercise [$1RM_r$]: 1.4 ± 0.3) participated in the study. All participants should perform RT for a minimum of 3 days per week for at least 1 year, regularly perform (minimum frequency of once a week) the exercises adopted in the experimental sessions and in the strength tests (bench press) for at least 1 year before entering the study and be free from any existing musculoskeletal disorders. Additionally, participants should state that they had not taken anabolic steroids, creatine and/or caffeine containing supplements for a minimum period of 6 months, answer negatively all questions on the Physical Activity Readiness Questionnaire (PAR-Q) and present a minimum relative one repetition-maximum (1RM) bench press value at least equal to total body mass (4). This study was approved by the University's research ethics committee (protocol 2.094.547) and was conducted in accordance with the Declaration of Helsinki and the ethical standards of the International Journal of Exercise Science (13); all subjects read and signed an informed consent document.

Protocol
This study followed a randomized cross-over design. Participants were asked to visit the laboratory in the following three different occasions: 1) getting anthropometric data; answering PAR-Q; bench press 1RM and 10RM tests for the exercises performed in the experimental conditions, and familiarization with the OMNI scale; 2) and 3) getting ultrasound images (pre and post each protocol) of muscle thickness (MT) and performing randomly one of the experimental protocols. The VL, TE and internal training load (ITL) for each protocol were also collected. The 1st and 2nd visits and the 2nd and 3rd visits were interspaced by 72 hours and 1 week, respectively. All volunteers were instructed to maintain their usual nutritional habits and refrain from any exercise 72 hours before performing the experimental protocols.

In a random order, participants were submitted to the following experimental protocols: Tri-set training (TRI) and traditional training (TRAD). In both conditions, volunteers were instructed to perform each set until the point of concentric muscular failure for 3 sets in the barbell bench press, machine bench press and cable fly exercises. If the participants were unable to perform 10 repetitions in a given set, load adjustments were implemented in the next one. During the TRAD protocol, participants performed 3 sets of 10 RM on the barbell bench press, followed by 3 sets of 10 RM on the machine bench press, and 3 sets of 10 RM on the cable fly. A passive rest period of 1 and 2 minutes was afforded between sets and exercises, respectively. During the TRI protocol, the participants performed for 3 times the following sequence: 1 set of 10 RM on the barbell bench press immediately (< 10 seconds) followed by 1 set of 10RM on the machine bench press and 1 set of 10 RM on the cable fly. A passive rest period of 2 minutes was afforded after the completion of the last exercise. A standard cadence of 4 seconds/repetitions was adopted using a metronome. Both training sessions were accompanied by the same researches in order to assure a proper technique for each exercise. All volunteers received a standardized verbal encouragement during the sessions.

Maximum dynamic strength was assessed through 1RM testing using the bench press exercise ($1RM_{BENCH}$). The testing protocol followed previous recommendations by NSCA (16). During the first set, subjects performed 5 repetitions at 50% of the estimated 1RM followed by one set of 3 repetitions at a load corresponding to 60– 80% of the estimated 1RM with a 3-minute rest interval between sets. After the warm-up sets, subjects had 5 attempts to find their 1RM load with 3-minute intervals between trials. The 1RM was deemed as the maximum weight that could be lifted no more than once with the proper technique. All testing sessions were supervised by the same researchers.

Ultrasound imaging was used to obtain measurements of muscle swelling of the pectoralis major muscle (PM_{MS}) immediately pre and 2 minutes-post both experimental protocols. A trained technician performed all testing using an A-mode ultrasound imaging unit (Bodymetrix Pro System; Intelametrix Inc., Livermore, CA, USA). Following a generous application of a water-soluble transmission gel (Mercur S.A. – Body Care, Santa Cruz do Sul, RS, Brazil) to the measured site, a 2.5-MHz linear probe was placed perpendicular to the tissue interface without depressing the skin. Equipment settings were optimized for image quality, according to the manufacturer's user manual, and maintained constant for the testing sessions. When the quality of the image was deemed to be satisfactory, the image was saved to the hard drive and MS dimensions were obtained by measuring the distance from the subcutaneous adipose tissue–muscle interface to the muscle-bone interface, according to methodology described by Abe et al. (1). Measurements were taken on the right side of the body and were standardized in 50% between the distance of axillary line and the nipple. To maintain consistency between the tests in each protocol (TRI and TRAD), each site was marked with henna ink (reinforced during the week). To further ensure accuracy of measurements, at least 3 images were obtained. If measurements were within 1mm of one another the figures were averaged to obtain a final value. The test-retest intraclass correlation coefficient (ICC) for PM_{MS} was 0.966. The coefficient of variation (CV) and the standard error of the measurement (SEM) from our lab for this measure are 1.0 and 0.29 mm, respectively. The data were expressed in millimeters (mm).

Volume load (VL) of each session (sets x repetitions x external load) (6) was calculated by the sum of the VL of the 3 sets performed. Only repetitions performed through a full range of motion were included for analysis. The data were expressed in kilograms (kg).

Training efficiency (TE) was calculated by dividing the VL by the training duration in minutes (19). The data were expressed in kilograms per minute ($kg.min^{-1}$).

Subjects reported their rating of perceived exertion for each session (sRPE), according to the OMNI-Resistance Exercise Scale (OMNI-RES), validated to measure RPE in RT (20). Subjects were shown the scale 10 minutes after each session and asked: "How intense was your session?" The internal training load (ITL) for each experimental condition was expressed as the product of the time under tension of each session in seconds (TUT) by the sRPE (6). The data were expressed in arbitrary units (AU).

Statistical Analysis

The normality and homogeneity of the variances were verified using the Shapiro-Wilk and Levene tests, respectively. Prior to analysis, all data were log-transformed for analysis to reduce bias arising from non-uniformity error (heteroscedasticity). The mean, standard deviation (SD) and 95% confidence intervals (CI) were used after data normality was assumed. To compare mean values of the PM_{MS}, VL, RPE, ITL and TE between-conditions (TRAD and TRI) a t-test for dependent samples was used. Post hoc comparisons were performed with the Bonferroni correction. The effect size (ES) between two means (TRAD vs TRI) was calculated to verify the magnitude of the differences by Cohen's d. The d results were qualitatively interpreted using the following thresholds: < 0.2, trivial; 0.2 - 0.6, small; 0.6 -1.2, moderate; 1.2 - 2.0, large; 2.0 - 4.0, very large and; > 4.0, extremely large. All analyses were conducted in SPSS-22.0 software (IBM Corp., Armonk, NY, USA). The adopted significance was $p \leq 0.05$.

RESULTS

No significant difference between conditions was observed in the baseline values of muscle thickness ($p = 0.691$). Figure 1 shows the absolute acute increases in muscle thickness for both experimental conditions. Significant differences were observed in PM_{MS} for both conditions

(TRAD: Δ = 12.7%, ES = 1.24, $p < 0.001$; TRI: Δ=26.1%, ES= 3.09, $p < 0.001$). However, a larger magnitude-absolute increase was observed during TRI compared to TRAD (ES = 1.69, CI 95% = 1.52).

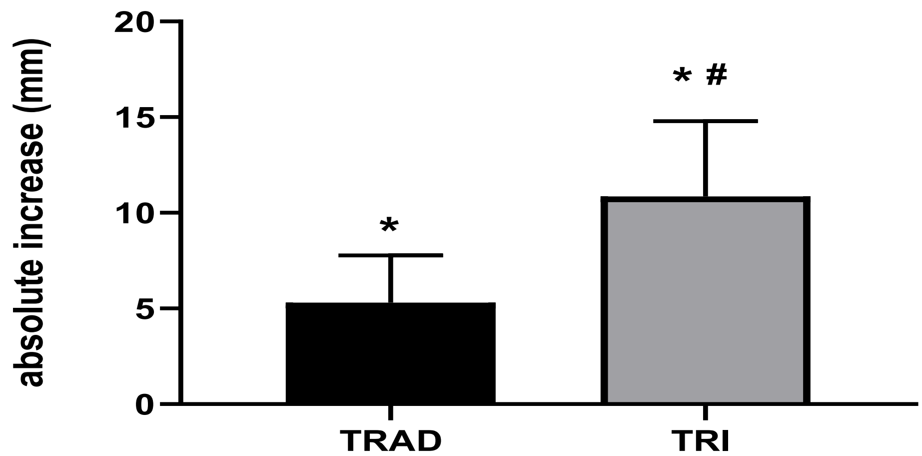

Figure 1. Acute increases in muscle thickness from pre to post-moment. **TRAD**= traditional training protocol; **TRI**= tri-set training protocol. * Significantly different from the pre-moment ($p < 0.001$); # Significantly different from the TRAD protocol ($p < 0.001$).

The mean ± standard deviation for RPE, TUT, ITL, session duration and TE are presented in table 1. In addition, the ES between conditions is also provided.

Table 1. Comparison of traditional training vs. tri-set training conditions in the dependent variables (mean ± SD).

Variables	**TRAD**	**TRI**	**Mean Difference** (CI 95%)	Δ%	***P* value**	**ES**
sRPE (AU)	7.1 ± 0.3	8.7 ± 0.4*	1.6 [1.4 to 1.9]	23.9	0.001	4.13
TUT (s)	259.0 ± 19.9	259.7 ± 20.0	0.7 [-12.8 to 14.0]	0.3	0.921	0.03
VL (kg)	6047 ± 847	4882 ± 579	-1166 [-1658 to -673]	19.3	0.001	1.61
ITL (AU)	1835.0 ± 168	2280.2 ± 223*	445 [331 to 579]	24.3	0.001	2.25
Session duration (min)	19.9 ± 1.0	10.3 ± 0.5*	-9.6 [-10 to -9]	48.2	0.001	11.2
TE ($kg.min^{-1}$)	304.4 ± 47	474.7 ± 72*	170 [129 to 211]	56	0.001	2.79

TRAD = traditional training protocol; **TRI** = tri-set training protocol; **sRPE** = session rate of perceived exertion; **TUT** = time under tension; **ITL** = Internal Training Load; **TE** = training efficiency. * Significantly different from TRAD protocol.

Figure 2 shows the individual values of VL in both experimental conditions. Significant differences were noted such as TRAD presented higher values compared to TRI (Δ = 19.3%, $p < 0.001$; mean difference = -1166, 95% CI = -1658 to -673; ES = 1.61).

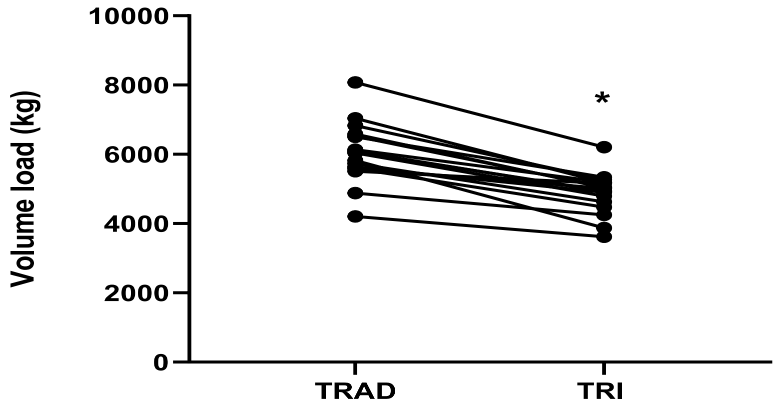

Figure 2. Individual values of VL (kg) during traditional (TRAD) and tri-set (TRI) protocols. * Significantly different from the TRAD protocol ($p < 0.001$).

DISCUSSION

The aim of the present study was to assess performance and metabolic acute responses to the TRI method. Confirming the initial hypothesis, a significant lower training volume (VL) was performed during TRI condition. Additionally, TRI also induced higher values of PM_{MS}, ITL and TE when compared to the TRAD session.

In order to maximize strength and hypertrophy adaptations, well-experienced lifters usually implement advanced techniques in their RT schedules, as drop-set, rest-pause, pyramid systems. The TRI is a popular method, especially for those individuals aiming to perform a large amount of volume per muscle group within a session, but with short time available. Then, scientific data regarding this advanced training system might help strength and conditioning practitioners/coaches to better understand its acute effects and how to implement it in training programs.

Regarding PM_{MS}, larger increases were observed for the TRI condition. This acute increase in MT would be detected by an intrinsic volume sensor which would result in the activation of anabolic pathways (23). Since swelling is a purposed mechanism that impacts net protein balance observed within acute sessions of RT, it is important to better understand if there are potential differences between RT systems in this variable. The results observed in the current study corroborate previous findings by Fink et al (5), in which a significant increase in muscle swelling (35.2 ± 16.9%) was observed only in the short rest interval protocol. In addition, other study reported higher values of muscle swelling even with reduced VL when performing advanced RT-techniques (3). Our results can be justified by the fact that a higher muscle swelling response is usually observed in exercise protocols that mostly relies in glycolytic pathway, triggering osmotic changes due to metabolite accumulation (23). In this sense, although somewhat speculative, TRI system might also be adopted by practitioners aiming to increase muscle size, since acute increases in muscle thickness are associated with triggering intracellular anabolic mechanisms, that lead to increased muscle protein synthesis (23, 25). Moreover, metabolic stress induced by RT involves an increase in intracellular hydration, and the raising of water content of the muscle cells which has been suggested as an important stimulus for muscle growth in a condition of higher metabolic accumulation (3, 10, 23). Future longitudinal studies assessing the effects of the TRI technique on muscle hypertrophy outcomes are encouraged in order to confirm this hypothesis.

For VL, higher values were observed for the TRAD condition compared to the TRI one (6047 kg vs 4882, respectively). It is widely described that the rest interval between sets can substantially influence the volume performed during resistance exercises (12, 24). Although no intervention assessed the effects of the TRI performed for the same muscle groups, several investigations has pointed that higher training volumes are performed in RT-protocols with long rest intervals compared to the shorter ones (17, 18) irrespective of the intensity adopted (28). The lower VL observed during the TRI might be explained by the higher metabolite accumulation and insufficient time to resynthesize muscular creatine-phosphate content usually described in increased TE protocols (9). Our findings corroborate a previous study that reported lower VL when trained subjects performed two exercises for the same muscle group (agonist super-sets) with a minimal rest interval compared to a TRAD protocol (26). Then, if one´s goal is to accumulate training load during a given session/period, TRAD system should be emphasized. However, within short time available-conditions, the TRI might be a viable option, since a higher TE was observed in the current study. In addition, in order to maintain higher VL values, coaches/practitioners may add an extra number of sets when performing TRI protocols (11).

Higher values of ITL were observed in TRI compared to TRAD protocol in the current study. This result can be mainly justified by the fact that, despite the similar TUT between conditions, a higher RPE was observed during the TRI condition. Although participants performed each set of both protocols with maximal effort, elevated levels of perceived effort have been previously described as a result of performing advanced techniques (5). In addition, this higher RPE reported during TRI might be justified by the increased values of TE observed in this experimental condition. It is also interesting to note that the session duration during TRI was 48.2% shorter than TRAD, suggesting that TRI may be a useful training technique that can be adopted for practitioners that aim to experience a high intensity of effort but dispose of reduced available time to perform the training sessions.

The ITL results observed by the current study differ from those reported by Weakley et al. (27), where a higher value was noted when performing TRAD protocol. However, some methodological differences must be considered when comparing both investigations. The TRI protocol in Weakley et al. (27) was performed with 3 exercises targeting different muscle groups (Barbell squat, Bench press and Deadlift) and ITL was calculated by a product of RPE and VL. Then, future investigations of TRI training system performed for the same muscle groups must be carried out in order to further clarify our findings regarding ITL-outcomes.

It is important to note that, although the present study was the first to assess the acute responses to TRI system targeting the same muscle groups, it is not without limitations. First, although the participants were advised to maintain their usual nutritional habits, no strict control of food intake prior to performing each experimental protocol was adopted. Then, eventual influences of nutritional factors must not be completely discarded. Second, eventual extrapolations regarding the findings of the current study must be done with caution, especially to the chronic effects of TRI, other populations (women, elderly, high-level athletes) and different muscle groups. Finally, future studies with additional assessments (e.g. hormone levels; muscle activation; blood lactate levels) must be carried out in order to further clarify the acute effects of performing TRI training system.

In conclusion, TRI is an efficient training system that might be implemented in structured training programs, especially when higher training efficiency and muscle swelling are desired. However, strength and conditioning coaches should be aware that the high levels of perceived effort induced by this system requires a stricter control of practitioner´s levels of fatigue and might also require an eventual larger time needed for increased recovery.

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REFERENCES

1. Abe T, DeHoyos DV, Pollock ML GL. Time course for strength and muscle thickness changes following upper and lower body resistance training in men and women. Eur J Appl Physiol 81(3): 174–81, 2000.

2. Ahtiainen JP, Pakarinen A, Alen M, Kraemer WJ, Häkkinen K. Muscle hypertrophy, hormonal adaptations, and strength development during strength training in strength-trained and untrained men. Eur J Appl Physiol 89(6): 555–63, 2003.

3. De Almeida FN, Lopes CR, Da Conceição RM, Oenning L, Crisp AH, De Sousa NMF, et al. Acute effects of the new method sarcoplasma stimulating training versus traditional resistance training on total training volume, lactate, and muscle thickness. Front Physiol 10(15): 1-7, 2019.

4. Brigatto FA, Braz TV, Zanini TC da C, Germano MD, Aoki MS, Schoenfeld BJ, et al. Effect of resistance training frequency on neuromuscular performance and muscle morphology after 8 weeks in trained men. J Strength Cond Res 33(8): 2104–16, 2019.

5. Fink J, Schoenfeld BJ, Kikuchi N, Nakazato K. Effects of drop set resistance training on acute stress indicators and long-term muscle hypertrophy and strength. J Sports Med Phys Fitness 58(5): 597–605, 2018.

6. Genner KM, Weston M. A comparison of workload quantification methods in relation to physiological responses to resistance exercise. J Strength Cond Res 28(9): 2621–7, 2014.

7. Hackett DA, Johnson NA, Chow CM. Training practices and ergogenic aids used by male bodybuilders. J Strength Cond Res 27(6): 1609–17, 2013.

8. Iglesias-Soler E, Carballeira E, Sánchez-Otero T, Mayo X, Fernández-Del-Olmo M. Performance of maximum number of repetitions with cluster-set configuration. Int J Sports Physiol Perform 9(4): 637–42, 2014.

9. Kelleher AR, Hackney KJ, Fairchild TJ, Keslacy S, Ploutz-Snyder LL. The metabolic costs of reciprocal supersets vs. traditional resistance exercise in young recreationally active adults. J Strength Cond Res 24(4): 1043–51, 2010.

10. Loenneke JP, Fahs CA, Rossow LM, Abe T, Bemben MG. The anabolic benefits of venous blood flow restriction training may be induced by muscle cell swelling. Med Hypotheses 78(1): 151–4, 2012.

11. Longo AR, Silva-Batista C, Pedroso K, de Salles Painelli V, Lasevicius T, Schoenfeld BJ, et al. Volume load rather than resting interval influences muscle hypertrophy during high-intensity resistance training. J Strength Cond Res Epub doi: 10.1519/JSC.0000000000003668, 2020.

12. Miranda H, Simão R, Moreira LM, de Souza RA, de Souza JAA, de Salles BF, et al. Effect of rest interval length on the volume completed during upper body resistance exercise. J Sport Sci Med 8(3): 388–92, 2009.

13. Navalta JW, Stone WJ, Lyons TS. Ethical issues relating to scientific discovery in exercise science. Int J Exerc Sci 12(1): 1–8, 2019.

14. Oliver JM, Kreutzer A, Jenke S, Phillips MD, Mitchell JB, Jones MT. Acute response to cluster sets in trained and untrained men. Eur J Appl Physiol 115(11): 2383–93, 2015.

15. Ozaki H, Kubota A, Natsume T, Loenneke JP, Abe T, Machida S, et al. Effects of drop sets with resistance training on increases in muscle CSA, strength, and endurance: A pilot study. J Sports Sci 36(6): 691–6, 2018.

16. Baechle TR, Earle RW. Principles of test selection. In: Essentials of strength training and conditioning. Champaign, IL: Human Kinetics; 2008.

17. Rahimi R. Effect of different rest intervals on the exercise volume completed during squat bouts. J Sport Sci Med 4(4): 361–6, 2005.

18. Ratamess NA, Falvo MJ, Mangine GT, Hoffman JR, Faigenbaum AD, Kang J. The effect of rest interval length on metabolic responses to the bench press exercise. Eur J Appl Physiol 100(1): 1–17, 2007.

19. Robbins DW, Young WB, Behm DG. The effect of an upper-body agonist-antagonist resistance training protocol on volume load and efficiency. J Strength Cond Res 24(10): 2632–40, 2010.

20. Robertson RJ, Goss FL, Rutkowski J, Lenz B, Dixon C, Timmer J, et al. Concurrent validation of the OMNI perceived exertion scale for resistance exercise. Med Sci Sports Exerc 35(2): 333–41, 2003.

21. Schoenfeld BJ. The mechanisms of muscle hypertrophy and their application to resistance training. J Strength Cond Res 24(10): 2857–72, 2010.

22. Schoenfeld BJ. The mechanisms of muscle hypertrophy and their application to resistance training. J Strength Cond Res 24(10): 2857–72, 2010.

23. Schoenfeld BJ. Potential mechanisms for a role of metabolic stress in hypertrophic adaptations to resistance training. Sports Med 43(3): 179–94, 2013.

24. Senna G, Salles BF, Prestes J, Mello RA, Simão R. Influence of two different rest interval lengths in resistance training sessions for upper and lower body. J Sport Sci Med 8(2): 197–202, 2009.

25. Wackerhage H, Schoenfeld BJ, Hamilton DL, Lehti M, Hulmi JJ. Stimuli and sensors that initiate skeletal muscle hypertrophy following resistance exercise. J Appl Physiol 126(1): 30–43, 2019.

26. Wallace W, Ugrinowitsch C, Stefan M, Rauch J, Barakat C, Shields K, et al. Repeated bouts of advanced strength training techniques: Effects on volume load, metabolic responses, and muscle activation in trained individuals. Sports 7(1): 14, 2019.

27. Weakley JJS, Till K, Read DB, Roe GAB, Darrall-Jones J, Phibbs PJ, et al. The effects of traditional, superset, and tri-set resistance training structures on perceived intensity and physiological responses. Eur J Appl Physiol 117(9): 1877–89, 2017.

28. Willardson JM, Burkett LN. The effect of rest interval length on bench press performance with heavy vs. light loads. J Strength Cond Res 20(2): 396–9, 2006.