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PARTIAL RANGE OF MOTION DOES NOT ALTER ACUTE REGIONAL MUSCLE RESPONSES IN ELBOW FLEXORS IN RECREATIONALLY TRAINED MEN

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ABSTRACT

This study examined the acute regional muscular responses to two unilateral isokinetic resistance-training (IRT) biceps curl protocols performed in partial ranges of motion (pROM) in recreationally trained men. Fifteen resistance-trained men (age 22.9 ± 2.8 years, total body mass 85.7 ± 13.0 kg, height 175.9 ± 7.4 cm) participated in this study. The participants performed 6 sets of 10 repetitions of concentric elbow flexion at 60°/s, with a 3-min rest interval between sets, in one of two different IRT protocols: (1) pROM between 0-60° (IRT_{0-60}) or (2) pROM between 60-120° (IRT_{60-120}). Muscle thickness (MT) and echo intensity (EI) were assessed pre-IRT, immediately post-IRT, and 15 min post-IRT at two elbow-flexor sites (30% and 70% of arm length). Peak torque (PT) and angular work (W) were assessed during the first and last sets, and session rating of perceived exertion (sRPE) was recorded 15 min after each protocol. PT decreased significantly across sets for both IRT protocols (IRT_{0-60}: 15.3% and IRT_{60-120}: 9.6%), with no protocol × set interaction. W remained unchanged between IRT protocols. MT increased predominantly at the 30% site in both IRT protocols, whereas responses at the 70% site were more limited and time-dependent. EI also increased over time (13.4–14.9%) without significant interactions. sRPE did not differ between IRT protocols. These findings indicate that pROM at short or long joint angles produces comparable acute reductions in PT, increases in MT and EI, and perceived effort when angular work (assessed in the first and last sets) is similar.

Keywords: *Exercise, Physical Performance, Ultrasound Imaging.*

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INTRODUCTION

Resistance training (RT) is an effective strategy for inducing acute neuromuscular and metabolic responses, such as cell swelling, muscle activation, and fatigue, which are often considered mechanistic stimuli underlying long-term adaptations including muscle hypertrophy, endurance, power, and strength (Scarpelli et al., 2022). However, it is important to emphasize that these adaptations occur over time and are influenced by multiple factors beyond acute responses. The magnitude and direction of chronic adaptations are largely dependent on the appropriate manipulation of acute RT variables (Marchetti, 2023; Schoenfeld, 2021; Schoenfeld, 2010; Schoenfeld & Grgic, 2020; Zatsiorsky et al., 2020). Therefore, acute responses should be interpreted primarily as mechanistic indicators rather than direct predictors of long-term outcomes.

Among RT variables, range of motion (ROM) has received considerable attention, as it directly influences mechanical load, time under tension, and muscle activation patterns, thereby contributing to distinct acute neuromuscular responses. In this context, skeletal muscle hypertrophy does not occur uniformly across the muscle length in longitudinal training studies, and emerging evidence suggests

that RT performed with partial ROM may be associated with region-specific hypertrophic outcomes over time (Antonio, 2000; Kassiano et al., 2025; Wakahara et al., 2013; Zabaleta-Korta et al., 2020; Zabaleta-Korta et al., 2023). The prevailing mechanistic hypothesis is that partial ROM may alter muscle stress at specific muscle lengths, based on the length–tension relationship, thereby influencing localized mechanical and neuromuscular demands during exercise. (Newmire & Willoughby, 2018). Nevertheless, this hypothesis has primarily been examined in chronic RT interventions, and the acute regional neuromuscular responses underpinning such adaptations remain poorly understood.

Zabaleta-Korta et al. (2023) compared the chronic effect of two exercises performed at different muscle lengths (50%, 60%, and 70% of arm length) in thirty-eight trained women. The participants completed a 9-week resistance training program (3 sessions per week), consisting of 4 sets of 12 repetitions performed to mechanical failure in either the incline biceps curl or the preacher curl. The results showed region-specific hypertrophic adaptations, with greater distal elbow flexor growth observed following training conditions that emphasized longer muscle lengths. Similarly, Kassiano et al. (2025) compared the effects of preacher and incline biceps curls on regional muscle hypertrophy and strength adaptations in a randomized controlled trial involving 63 young women. Participants trained for 8 weeks (2 sessions per week) performing either the preacher curl or incline curl exercise. Muscle thickness was assessed at proximal, middle, and distal sites of the elbow flexors, and strength was evaluated using exercise-specific 3RM tests. The authors reported region-specific hypertrophic responses, with the incline biceps curl producing greater increases in proximal muscle, whereas the preacher curl elicited greater increases in distal thickness. In addition, strength adaptations were specific to the trained movement, with greater improvements in preacher curl 3RM observed in the preacher curl group and greater improvements in incline curl 3RM in the incline curl group. Collectively, these findings further support the presence of region-specific and exercise-specific adaptations of the elbow flexors in response to different exercise variations. Although several studies have demonstrated region-specific hypertrophy following RT interventions (Attarieh et al., 2025; Kassiano et al., 2025; Longrak, 2024; Zabaleta-Korta et al., 2020; Zabaleta-Korta et al., 2023), the acute neuromuscular and morphological responses that may help explain these chronic adaptations remain unclear. It is not yet known whether different partial ROM resistance exercise configurations elicit region-specific acute muscle responses.

Therefore, the purpose of this study was to compare the acute regional muscular responses of two unilateral isokinetic resistance-training (IRT) biceps curl protocols with partial range of motion (pROM) on muscle thickness (MT), echo-intensity (EI), peak torque (PT), angular work (W), and perception of effort (sRPE) in recreationally trained men. The main hypotheses are that: (1) peak torque and angular work will decrease from the first to the last sets in both IRT protocols, reflecting acute neuromuscular fatigue and reduced force-producing capacity across repeated efforts; (2) IRT protocols with different pROM will induce distinct changes in muscle thickness and echo intensity at specific muscle sites, indicating region-dependent morphological and architectural responses; and (3) session rating of perceived exertion will be similar between IRT protocols. The rationale for this study is that specific ranges of motion modulate not only the distribution of acute mechanical

stress and morphological strain across muscle regions but also the expression of force production and fatigue-related declines in torque output. In this context, variations in pROM may differentially influence both regional structural responses (e.g., MT and EI) and global neuromuscular performance outcomes (e.g., PT and W), thereby providing mechanistic insight into how exercise configuration shapes integrated morphological and strength-related responses, which may help explain region-specific adaptations reported in chronic training studies.

METHODS

Participants

The sample size was determined a priori based on a pilot study conducted with individuals of the same characteristics as those enrolled in the present study (Marchetti et al., 2023). Using MT as the primary outcome, a significance level of $\alpha = .05$ and a statistical power of 80% ($1–\beta = 0.80$) indicated that a minimum of 15 participants would be required to detect meaningful differences. Fifteen resistance-trained men were assigned to this study [age 22.9 ± 2.8 years, total body mass 85.7 ± 13.0 kg, height 175.9 ± 7.4 cm]. All participants had been regularly engaged in an RT routine for more than 1 year and were familiar with hypertrophy-type training and the standing unilateral biceps curl exercise. They had 3 ± 1 years of resistance training experience (at least twice per week), with no previous surgery or history of injury with residual symptoms (pain) in the upper limbs or spine within the last year. The participants were informed of the risks and benefits of the study prior to any data collection and then read and signed an institutionally approved informed consent document by the Institutional Review Board at California State University, Northridge (#00001788/2023).

Procedures

The order of the two IRT protocols was randomized and counterbalanced across participants. Participants attended two laboratory sessions spaced 1 week apart and were instructed to refrain from any upper-body exercise for at least 72 hours before each testing session. This pre-session restriction was applied to standardize recovery status and minimize residual effects from prior training. All participants were asked to identify their preferred writing arm, which was considered their dominant arm (Maulder, & Cronin, 2005). In each session, one of two IRT protocols was randomly tested: 1) Partial ROM between 0-60° (IRT0-60) or 2) Partial ROM between 60-120° ($IRT_{60\text{-}120}$). Both IRT protocols were performed using the dominant arm. To perform the unilateral biceps curl exercise on the isokinetic equipment (HUMAC®/NORM™ Testing and Rehabilitation System, Stoughton, MA, USA), all participants were positioned supine on the dynamometer chair, a belt was placed around the pelvis, a shoulder belt was placed across the torso, and all participants kept a supinated grip on the handle. The isokinetic equipment was set to one of two partial ranges of motion (0-60° or 60-120°), and all participants performed only the concentric elbow flexion phase at $60°\cdot s^{-1}$. The researcher returned the lever to the initial position after the concentric phase of elbow flexion, avoiding the participant's eccentric action in all repetitions.

During the first session, anthropometric data (height, body mass, and arm length) were collected. Subsequently, all participants completed a familiarization and specific warm-up consisting of one set of five repetitions at $60°\cdot s^{-1}$ using the partial range of motion (ROM) IRT protocol at 0–60°, followed by one set of five repetitions at $60°\cdot s^{-1}$ using the partial ROM IRT protocol at 60–120°. A five-minute rest period was allowed between the spe-

cific warm-up and the execution of one of the two IRT protocols. Ultrasound images of the elbow flexors were obtained before and after each IRT protocol [immediately post-exercise (post-0) and 15-min post-exercise (post-15)] at two muscle sites corresponding to 30% and 70% of arm length. Participants performed six sets of 10 concentric repetitions at $60° \cdot s^{-1}$, with 3-min rest intervals between sets, using one of the two IRT protocols ($IRT_{0\text{-}60}$ or $IRT_{60\text{-}120}$). All participants reported their rating of perceived exertion (sRPE) 15 min after completing each IRT protocol.

During the second session, participants performed the alternate IRT protocol ($IRT_{0\text{-}60}$ or $IRT_{60\text{-}120}$), and all measurements were repeated following the same procedures as in the first session. Participants received standardized verbal encouragement during both IRT protocols. All testing sessions were conducted between 1 PM and 4 PM and administered by the same researcher (CSCS-certified).

Measurements

Peak Torque (PT): Peak torque was defined as the mean of the highest torque values derived from the torque–angle curves across the 10 concentric repetitions performed during the first and last sets of each IRT protocol. These PT values were used for subsequent statistical analyses.

Angular Work (W): Angular work was defined as the matched total angular work, calculated as the area under the torque–angle curve for each of the 10 concentric repetitions performed during the first and last sets of each IRT protocol. These W values were used for subsequent statistical analyses.

Muscle Thickness (MT): Muscle thickness was assessed using B-mode ultrasound imaging. All measurements were performed by a trained technician using a portable ultrasound device (Hitachi Noblus; Hitachi Medical Corporation, Tokyo, Japan). A generous amount of water-soluble transmission gel (Cskin; Medics Medical Products LLC., NY, USA) was applied to the measurement site, and a 7.5-MHz linear-array transducer (L55 probe) was positioned perpendicular to the tissue interface without compressing the skin. Ultrasound settings were optimized for image quality (depth: 8 cm; brightness/B-mode gain: 35) according to the manufacturer's guidelines and were held constant across all testing sessions. Muscle thickness was determined as the distance between the subcutaneous adipose tissue–muscle interface and the muscle–bone interface, following previously described procedures by Abe et al. (2014). Measurements were obtained from the dominant arm over the elbow flexors while participants were in a standing position. Imaging sites were located at 30% and 70% of the arm length, defined as the distance from the lateral epicondyle of the humerus to the acromion process of the scapula, and were marked with ink to ensure consistent measurements across sessions. The selection of these measurement sites was based on a prior pilot study identifying regional differences along the muscle length. Muscle thickness was assessed before (pre-test) and after each IRT protocol (post-0 and post-15). To enhance measurement reliability, a minimum of three images were acquired at each muscle site. If measurements differed by more than 1 mm, a fourth image was obtained and averaged with the others. Images deemed acceptable in quality were saved for offline analysis. Test–retest intraclass correlation coefficients (ICC) for MT ranged from 0.96 to 0.98, and intra-rater reliability ranged from 0.96 to 0.97.

Echo Intensity (EI): The same ultrasound images used to assess muscle thickness were analyzed to quantify echo intensity. Echo intensity was determined using automated grayscale analysis, with values ranging from 0

(black) to 255 (white) arbitrary units (A.U.). A rectangular region of interest (ROI) was drawn as large as possible to encompass the muscle cross-section, while carefully excluding surrounding fascia, subcutaneous adipose tissue, and bone. Each EI measurement was performed twice, and the mean value was used for statistical analysis. Echo intensity was assessed before (pre-test) and after each IRT protocol (post-0 and post-15). The test–retest ICC for EI was .97.

Session rating of perceived exertion (sRPE): sRPE was assessed using the CR-10 scale in accordance with the recommendations of Sweet et al. (Sweet et al., 2004). Participants were instructed to rate their overall perceived effort for each IRT protocol using arbitrary units (A.U.), where 0 represented no effort, and 10 represented maximal effort ever experienced. All participants responded to the standardized question: *"How was your workout?"* The sRPE was recorded 15 min following the completion of each IRT protocol.

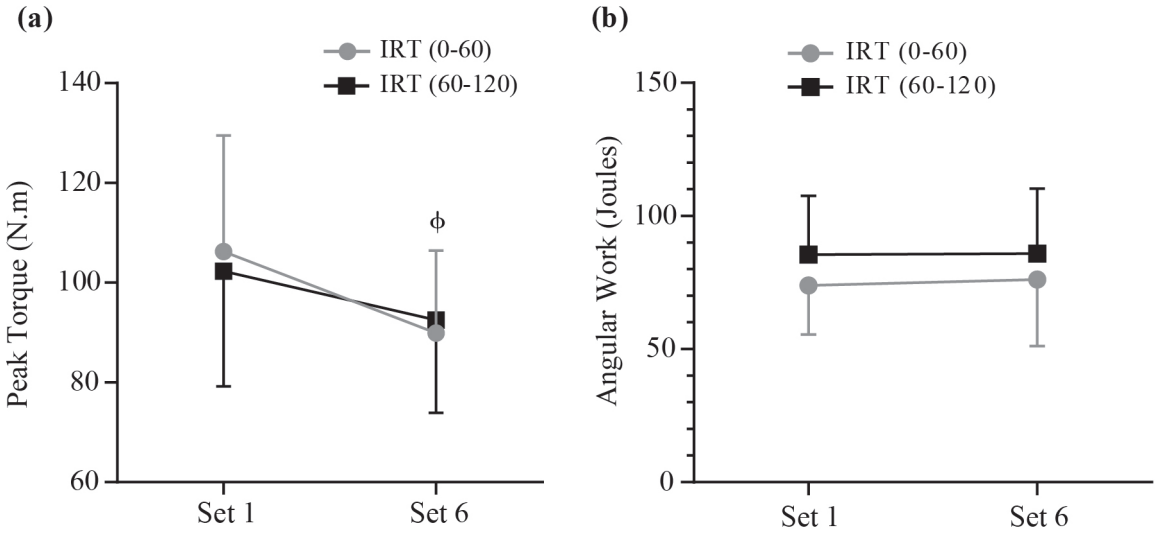
Statistical Analyses

Data normality and homogeneity of variances were assessed using the Shapiro–Wilk and Levene's tests, respectively. Descriptive statistics are presented as mean ± standard deviation (SD), delta percentage (Δ%). A two-way repeated-measures ANOVA (2 × 2) was used to examine differences between IRT protocols ($IRT_{0\text{-}60}$ and $IRT_{60\text{-}120}$) and sets (set 1 and set 6) for peak torque (PT) and angular work (W). A three-way repeated-measures ANOVA (2 × 2 × 3) was conducted to assess differences among IRT protocols ($IRT_{0\text{-}60}$ and $IRT_{60\text{-}120}$), muscle site (30% and 70% of arm length), and time (pre-test, post-0, and post-15) for muscle thickness (MT) and echo-intensity (EI). For repeated-measures factors with more than two levels, the assumption of sphericity was evaluated using Mauchly's test. When the assumption was violated, the Greenhouse–Geisser correction was applied. When significant main effects or interactions were detected, post-hoc comparisons were performed using the Bonferroni adjustment. A paired-samples *t* test was used to compare session ratings of perceived exertion (sRPE) between IRT protocols. Effect sizes were calculated using Cohen's *d* and interpreted according to the following thresholds for recreationally trained individuals: <0.35 (trivial), 0.35–0.80 (small), 0.80–1.50 (moderate), and >1.50 (large) (Rhea, 2004). Statistical significance was set at an alpha level of 0.05. All statistical analyses were performed using IBM SPSS Statistics version 21 (IBM Corp., Armonk, NY, USA).

RESULTS

For PT (Figure 1a), a significant main effect was observed for sets (p = .008) with no significant main effect for IRT protocols (p = .730). No significant interaction was observed between IRT protocol and set (p = .236). Post-hoc analyses revealed significant differences between sets 1 and 6 for both protocols: $IRT_{0\text{-}60}$ (p = .005; d = 0.81, moderate; Δ% = 15.3) and $IRT_{60\text{-}120}$ (p = .002; d = 0.47, small; Δ% = 9.6).

For W (Figure 1b), no significant main effects were found for sets (p = .808) or IRT protocol (p = .170), and there was no significant interaction between IRT protocol and set (p = .820).



Note. ϕ Significant difference between sets for both IRT protocols, $p < .01$.

Figure 1. *Mean and standard deviation of (a) peak torque and (b) angular work between the first (Set 1) and last set (Set 6) for both IRT protocols.*

For MT (Figure 2a), significant interactions were found for time × muscle site ($p < .001$) and time × IRT protocol ($p = .018$), with no interactions for IRT protocol × muscle site ($p = .307$) and IRT protocol × time × muscle site ($p = .485$). Significant main effects were observed for time ($p < .001$) and muscle site ($p < .001$), with no main effect for IRT protocol ($p = .369$).

For $IRT_{0\text{-}60}$, at the 30% muscle site, post-hoc comparisons revealed significant increases in MT between pre-test and post-0 ($p < .001$; $d = 1.08$, moderate; $\Delta\% = 12.4$), pre-test and post-15 ($p < .001$; $d = 0.67$, small; $\Delta\% = 7.8$), and post-0 and post-15 ($p < .001$; $d = 0.38$, small; $\Delta\% = 4.8$).

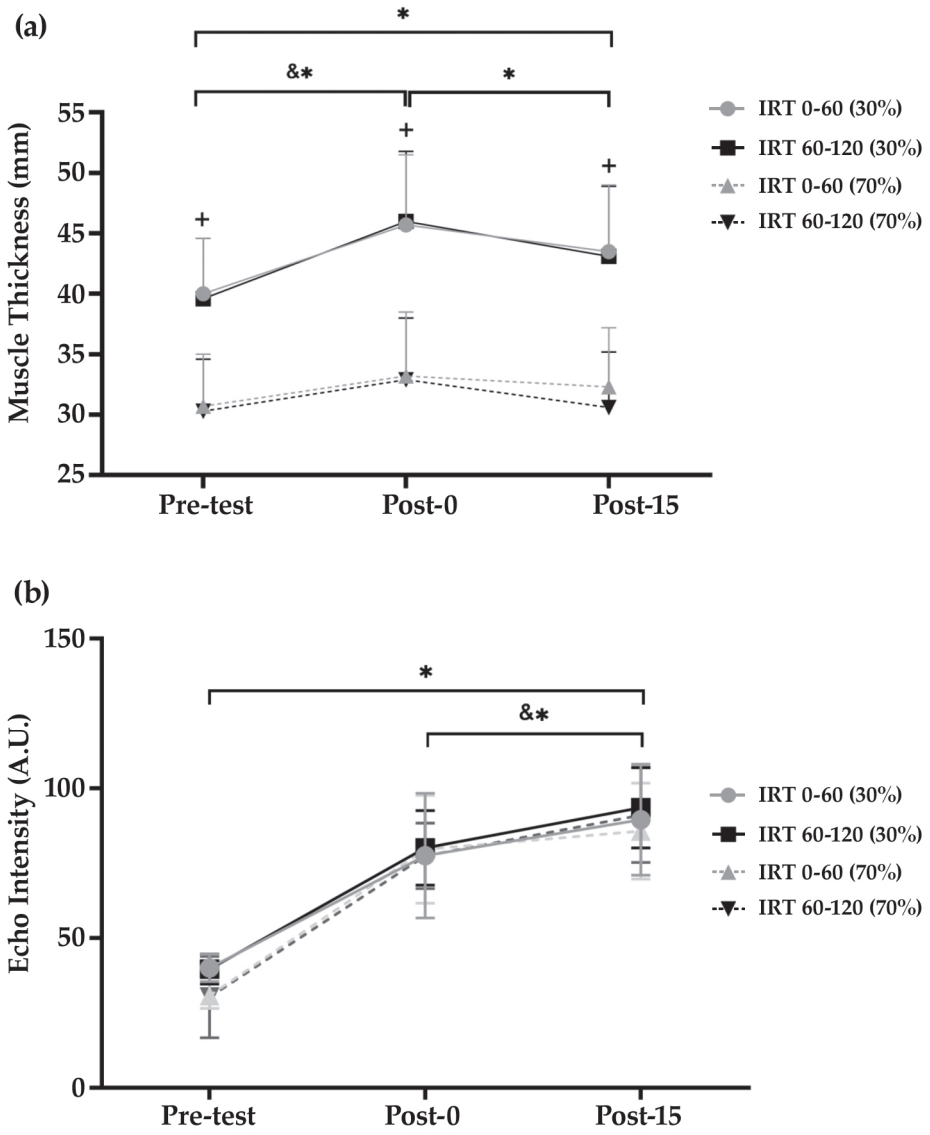
For $IRT_{60\text{-}120}$, at the 70% muscle site, MT increased significantly from pre-test to post-0 ($p = .019$; $d = 0.55$, small; $\Delta\% = 7.9$). At the 30% muscle site, significant differences were observed between pre-test and post-0 ($p < .001$; $d = 1.18$, moderate; $\Delta\% = 13.9$), pre-test and post-15 ($p < .001$; $d = 0.63$, small; $\Delta\% = 7.9$), and post-0 and post-15 ($p = .001$; $d = 0.52$, small; $\Delta\% = 6.5$).

Additionally, at the 70% muscle site, MT was significantly greater at post-0 compared with post-15 ($p = .038$; $d = 0.47$, small; $\Delta\% = 6.9$).

For EI (Figure 2b), no significant interactions were found for time × muscle site ($p = .576$), time × IRT protocol ($p = .161$), muscle site × IRT protocol ($p = .907$), and IRT protocol × time × muscle site ($p = .377$). Significant main effects were observed for time ($p < .001$), with no main effects for IRT protocol ($p = .210$) and muscle site ($p = .810$).

For $IRT_{0\text{-}60}$, EI at the 30% muscle site was significantly higher at post-15 compared with pre-test ($p = .010$; $d = 0.60$, small; $\Delta\% = 13.4$). For $IRT_{60\text{-}120}$, a significant increase in EI was observed at the 70% muscle site between post-0 and post-15 ($p = .005$; $d = 0.99$, moderate; $\Delta\% = 14.9$).

For session rating of perceived exertion (sRPE), no significant difference was found between $IRT_{0\text{-}60}$ and $IRT_{60\text{-}120}$ (8.9 ± 1.1 vs. 8.6 ± 1.1, respectively; $p = .333$).



Note. +Significant difference between 30% and 70% for both IRT protocols; *Significant difference between times for 30% for both IRT protocols ($IRT_{0\text{-}60}$ and $IRT_{60\text{-}120}$); &Significant difference between times for 70% for $IRT_{0\text{-}60}$.

Figure 2. *Mean and standard deviation of (a) muscle thickness and (b) echo intensity for the two IRT protocols, muscle sites, and time.*

DISCUSSION

This study examined the acute regional muscular responses to two unilateral IRT biceps curl protocols performed in partial ranges of motion in recreationally trained men. The main findings included: 1) PT was reduced after both IRT protocols; 2) W did not change after both IRT protocols; 3) IRT protocols with pROM showed similar increases in MT in both muscle sites; 4) IRT protocols with pROM showed similar increases in EI in both muscle sites; and 5) sRPE was similar between IRT protocols. To the authors' knowledge, this is the first study to directly compare acute neuromuscular, perceptual, and regional muscle morphology responses across distinct pROM configurations during unilateral isokinetic elbow flexion exercise performed under controlled angular-velocity conditions. This experimental approach provides novel insight into the acute physiological effects of ROM manipulation while minimizing the confound-

ing influence of variable movement velocity and external resistance typically observed in traditional RT settings.

Initially, the present study assessed peak torque (PT) and angular work (W) to characterize acute neuromuscular performance and fatigue during two pROMs. The hypotheses were that PT and W would decrease from the first to the last set in both IRT protocols. These variables were selected to capture acute changes in force production capacity across repeated contractions, rather than to infer long-term RT adaptations. From a mechanistic standpoint, the length–tension relationship indicates that force production varies with muscle length due to differences in actin–myosin overlap and passive tension contributions (Gordon et al., 1966; Lieber & Friden, 2000). Based on this concept, it was expected that IRT protocols performed at different ranges of motion (0–60° vs. 60–120°) could produce distinct patterns of acute neuromuscular fatigue, potentially reflected in PT loss. Furthermore, although chronic training studies suggest that longer muscle lengths may be associated with greater mechanical tension and hypertrophic outcomes over time (Antonio, 2000; Attarieh et al., 2025; Kassiano et al., 2025; Wolf et al., 2026), such interpretations pertain to longitudinal adaptations and should not be directly inferred from acute RT responses. In this study, both IRT protocols showed reductions in PT from the first to the last set, consistent with the development of acute neuromuscular fatigue. Although numerically greater reductions were observed in $IRT_{0–60}$ (15.3%; d = 0.81, moderate) compared to $IRT_{60–120}$ (9.6%; d = 0.47, small), these differences were not statistically significant. This result suggests that both IRT protocols imposed a similar magnitude of acute neuromuscular stress, despite differences in ranges of motion. These findings indicate that, when angular work in the first and last sets did not differ between IRT protocols, ROM manipulation alone did not meaningfully alter the acute neuromuscular fatigue profile as assessed by PT. The observed reductions in PT across sets align with established mechanisms of acute neuromuscular fatigue during repeated high-intensity contractions, which involve both peripheral and central processes (Enoka & Duchateau, 2016). Peripheral fatigue mechanisms include metabolite accumulation and impaired excitation–contraction coupling, whereas central fatigue involves reduced motor drive and altered motor unit recruitment strategies (Allen et al., 2008). Therefore, the present PT responses reflect expected acute neuromuscular adjustments during repeated maximal isokinetic efforts. In contrast, angular work (W) remained stable across sets and between IRT protocols. Under isokinetic conditions, matched total angular work can be maintained even in the presence of declining PT, owing to velocity constraints that allow redistribution of force across the movement range (Dvir, 2025). This dissociation reinforces the idea that PT and W capture different dimensions of acute neuromuscular performance: PT reflects maximal instantaneous force capacity, whereas W reflects total mechanical output across the contraction.

Perceptual responses, assessed via sRPE, were also similar between IRT protocols. The sRPE scale is a validated indicator of internal load and overall physiological strain during RT exercises and sessions (Foster et al., 2001; Haddad et al., 2017; Halperin & Emanuel, 2019; Weilharter et al., 2024). The comparable sRPE responses suggest that participants experienced similar acute effort across both IRT protocols, supporting the mechanical findings of matched total angular work output in the analyzed sets and equivalent perceived effort.

Continuing the analysis of acute RT responses, muscle morphology and quality

were assessed using MT and EI, respectively. MT is widely used as an indirect marker of acute exercise-induced cellular and fluid shifts, which are commonly associated with transient muscle swelling (Wong et al., 2020; Yitzchaki et al., 2019). Although MT responses are often discussed within the context of hypertrophy research, in the present acute setting they should be interpreted exclusively as short-term physiological alterations rather than indicators of chronic muscle growth. Acute increases in MT following RT are generally attributed to fluid redistribution, metabolite accumulation, and elevated blood flow (Behrens et al., 2023; Chen et al., 1996; Hirono et al., 2022; Schoenfeld & Contreras, 2014; Sjøgaard et al., 1985; Usher-Smith et al., 2009). These transient responses are considered markers of acute metabolic stress but do not directly reflect long-term morphological adaptations. While both metabolic stress and mechanical tension are known to contribute to cellular signaling pathways associated with chronic adaptation (Lim et al., 2022; Schoenfeld, 2010), the acute design of the present study does not permit inferences regarding long-term hypertrophic outcomes.

Both IRT protocols elicited comparable increases in MT and EI. Based on the study hypothesis, it was expected that different pROMs would produce site-specific differences in acute muscular responses. However, the significant interactions indicate that the magnitude and temporal pattern of MT changes varied according to the measurement site and IRT protocol. In this case, the absence of a significant time × IRT protocol × muscle site interaction indicates that the IRT protocol-dependent temporal pattern of MT responses did not differ significantly between measurement sites. Importantly, the novelty of this study resides in the use of an isokinetic model to isolate the acute effects of pROM manipulation on regional muscular responses while maintaining controlled movement velocity and standardized effort between RT conditions. Previous investigations examining ROM-related adaptations have predominantly focused on chronic RT outcomes or utilized dynamic external loading conditions, making direct interpretation of acute physiological responses more difficult.

In contrast to MT, EI increased over time, with no significant interactions. Thus, the EI findings provided stronger evidence of a comparable temporal response across the two pROM conditions and measurement sites than the MT findings. EI increased to a similar extent following both IRT protocols, with small-to-moderate effect sizes (d = 0.60–0.99, depending on muscle site and condition). EI has been proposed as a non-invasive marker of muscle composition and intramuscular fluid distribution, with higher values often reflecting increased fluid content or transient structural alterations (Wong et al., 2020; Yitzchaki et al., 2019). In the present study, EI increased by approximately 13.4–14.9% from pre- to post-test across both IRT protocols, indicating acute fluid accumulation within the assessed muscle regions. The parallel increases in MT and EI, with effect sizes ranging from small to large (MT: d = 0.38–1.18; EI: d = 0.60–0.99), further supported the interpretation that both IRT protocols induced similar magnitudes of acute regional muscular stress. Importantly, these results should be interpreted within the context of acute IRT responses and should not be extrapolated to infer region-specific hypertrophy or long-term morphological adaptations. Rather, the present results provide mechanistic insight into how different pROM configurations influence immediate neuromuscular and morphological responses under controlled isokinetic conditions.

Several limitations should be acknowledged. The modest sample size and multiple comparisons may have limited statistical power; however, the effect size analysis provided meaningful additional insights into the magnitude of the observed responses. Second, lactate and other metabolic by-products were not measured, which limits understanding of the physiological mechanisms underlying neuromuscular fatigue. Third, the findings have limited external validity, as the experimental protocol was performed using an isokinetic dynamometer operating at a fixed angular velocity ($60°·s^{-1}$) and included only concentric muscle actions. This highly controlled setting enhances internal validity but does not fully reflect typical RT environments, where movement velocity varies, and both concentric and eccentric actions are commonly performed. Therefore, caution is warranted when extrapolating these results to traditional free-weight or machine-based RT. Finally, caution is also warranted when generalizing these findings to multi-joint exercises, different RT protocols, or populations such as youth, competitive athletes, or older adults.

CONCLUSIONS

In conclusion, isokinetic resistance training performed in two distinct partial ranges of motion (0–60° vs. 60–120°) elicited comparable acute reductions in peak torque, maintenance of angular work, and increases in muscle thickness and echo intensity. For MT, significant interactions indicated that the magnitude and temporal pattern of the acute response varied across measurement sites and IRT protocols. However, the absence of a significant time × muscle site × protocol interaction indicates that these effects did not differ in combination. Overall, the present findings indicate that partial ROM manipulation can influence the temporal pattern of acute muscle thickness responses under controlled isokinetic RT conditions, although the data do not demonstrate a clear protocol-specific regional acute response. These responses occurred under conditions in which angular work (assessed in the first and last sets) and perceived effort were similar between protocols.

PRACTICAL APPLICATIONS

The present findings indicate that manipulating partial range of motion during unilateral isokinetic elbow-flexion exercise does not necessarily alter the magnitude of acute neuromuscular fatigue, perceived effort, or acute regional muscle responses when RT volume and mechanical output are comparable. Both 0–60° and 60–120° ROM protocols produced similar reductions in peak torque, maintained angular work, and comparable increases in muscle thickness and echo intensity across the assessed elbow flexor regions. From a practical perspective, this suggests that different pROM configurations can be used to provide a similar acute RT stimulus, allowing range of motion to be selected according to exercise goals, equipment constraints, or individual tolerance without necessarily increasing acute neuromuscular fatigue or perceptual effort. However, the acute increases in muscle thickness and echo intensity should not be interpreted as evidence that either pROM configuration produces greater hypertrophy. Long-term studies using conventional RT exercises are needed to determine whether these acute responses translate into differential chronic adaptations.

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Competing Interests

The authors have no conflicts of interest to disclose.

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