

Original Research

Effects of Two Different Preacher Curl Training Programs on Regional Hypertrophy: An Experimental Study

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Abstract: This study explored the regional muscle hypertrophic effect of the preacher curl training between two distinct program designs. Twenty healthy young males (age: 21.1 ± 0.4 years; height: 174.1 ± 5.1 cm, weight: 69.1 ± 11.3 kg) were recruited and randomly allocated to the 6-week programs of either mechanical tension program (MT) or mechanical tension with metabolic stress program (MTMS). Biceps brachii cross-sectional area (CSA) and thickness at proximal and distal regions were assessed by magnetic resonance imaging (MRI) and B-mode ultrasonography (US), respectively. Furthermore, fascia thickness was measured together with muscle thickness. Results indicated significant increases in biceps brachii CSA at both the proximal and distal regions in both programs ($p < 0.05$). Interestingly, muscle CSA at the distal region exhibited a more pronounced growth with larger effect sizes compared to the proximal region in both MT ($\Delta 12.15\%$, $p = 0.000$, $ES = \text{Moderate}$ vs $\Delta 8.26\%$, $p = 0.038$, $ES = \text{Small}$) and MTMS ($\Delta 16.92\%$, $p = 0.008$, $ES = \text{Moderate}$ vs $\Delta 9.02\%$, $p = 0.005$, $ES = \text{Small}$). Moreover, US further confirmed these findings, both MT and MTMS showed only significant increases in biceps brachii thickness at the distal region ($\Delta 25.95\%$, $p = 0.000$, $ES = \text{Large}$, and $\Delta 21.76\%$, $p = 0.009$, $ES = \text{Large}$, respectively). Interestingly, fascia remodeling interestingly showed that significant thickness increased at distal region only in MTMS ($\Delta 47.27\%$, $p = 0.006$, $ES = \text{Large}$). In conclusion, our study confirmed that the preacher curl exercise per se induced regional hypertrophy preferentially in the distal region of the biceps brachii muscle, while resistance training program design had no discernible effect on this hypertrophic pattern.

Keywords: Muscle thickness; Muscle cross-sectional area; Fascia thickness; Preacher curl; Hypertrophy training

1. Introduction

Resistance training remains highly popular in contemporary society, with an increasing number of individuals turning to gym facilities for bodybuilding purposes. Consequently, research endeavors have intensified, focusing on strategies to enhance muscle mass, commonly referred to as muscle hypertrophy (Schoenfeld, 2010).

Scientists have looked into various factors like resistance training intensity: how heavy should it be? (Campos et al., 2002; Lasevicius et al., 2018; Lopez et al., 2021), volume: how many sets should one train? (Baz-Valle et al., 2022; Brigatto et al., 2022; Schoenfeld et al., 2019), rest periods: how much should one rest between set? (Schoenfeld et al., 2016), range of motion: does full range of motion



always result in better hypertrophy? (Bloomquist et al., 2013; Kubo et al., 2019), training frequency: how many times per week is most effective? (Gentil et al., 2015; McLester et al., 2000), full or split-training routine (Evangelista et al., 2021), exercise order: should it be trained with multi-joint or single joint exercise first (Gentil et al., 2015), and exercise techniques: is drop-set a magic pill for muscle growth? (Goto et al., 2003; Kelleher et al., 2010) to figure out the most effective muscle-building strategies, aiming to elucidate optimal practices for maximizing training effort (Krzysztofik et al., 2019).

While several studies have shed light on these interesting variables, comparatively little attention has been given to the specific exercise and its impact on regional hypertrophy (Saeterbakken et al., 2013). Previous research has demonstrated muscle growth was non-uniform (Zabaleta-Korta et al., 2023), indicating that hypertrophy did not occur uniformly along the length of a muscle (e.g. proximal region versus distal region) (Nunes et al., 2024). For example, it was demonstrated that significant increase in rectus femoris muscle up to 27.9% compared to only 19.5%, and 17.4% increases of vastus lateralis and vastus intermedius, respectively, after training with leg extension exercise (Narici et al., 1996). On the other hand, squats had been shown to be highly effective for inducing vastus medialis hypertrophy but were ineffective for targeting the rectus femoris (Kubo et al., 2019). Moreover, previous study had found that leg press exercise induced preferential hypertrophy at the distal region of the quadriceps than proximal region (Franchi et al., 2014). From these examples in lower

musculature, therefore, investigating which exercise induces greater hypertrophy at which specific region along the muscle length holds significant practical implications for practitioners.

Building upon the aforementioned literature, this study aimed to investigate regional biceps brachii hypertrophy resulting from preacher curl exercise with two different training programs.

2. Materials and Methods

Study design

This study employed a single-blinded experimental design with two experimental groups. The training program was standardized for both groups, starting with 3 sets in the first two weeks, progressing to 6 sets in the next two weeks, and finally 8 sets in the last two weeks, for a total duration of six weeks. The training sessions were conducted in a controlled environment at the Physiology Laboratory of the Faculty of Sport Science. Additionally, other training variables such as execution pattern, repetition tempo, and rest intervals were consistently controlled in every training session. Eligibility criteria required participants to have no prior resistance training experience to minimize experience-related biases. Resistance training was closely supervised by a certified personal trainer in a laboratory setting. Baseline testing included Magnetic resonance imaging (MRI) and Ultrasonography (US) assessments for muscle CSA and thickness, as well as fascia thickness. This study conformed to the ethical guidelines of the Declaration of Helsinki and ethical approval

was granted by the Burapha University ethics committee (G-HS046/2566(C1)).

Participants - Twenty healthy young untrained males (age: 21.1 ± 0.4 years; height: 174.1 ± 5.1 cm, weight: 69.1 ± 11.3 kg) were recruited from the Faculty of Sports Science. Utilizing G*power 3.1.9.7 for sample size calculation (with a priori power analyses including Effect size = 0.75, $\alpha = 0.05$, Power = 0.80), the total sample size was 17 with considering 20% dropout rate allowed; therefore, the total number of participants in this study was 20. These input parameters were following the previous study which employed the similar experimental design (Zaroni et al., 2019). Inclusion criteria ensured participants had 1) no functional limitations, 2) no history of substance use affecting muscle metrics, or 3) no resistance training experience. General health screenings were conducted by a registered physician, and written informed consent was obtained from all participants. Participants were randomly assigned to mechanical tension program (MT, $n=10$) or mechanical tension with metabolic stress program (MTMS, $n=10$) by research randomizer program to avoid bias.

Preacher curl training programs - Two different preacher curl training programs, each utilizing distinct hypertrophic stimuli differently designed according to different hypertrophy stimuli (Schoenfeld, 2010), were implemented over six weeks with one session per week. The rationale behind employing two different training programs was to assess potential variations in regional muscle hypertrophy despite utilizing the same exercise

Before the experiment, each participant's one-repetition maximum (1RM) was determined according to NSCA guidelines (Brown, 2016). Participants performed an aerobic warm-up, followed by light resistance preacher curls for 8-10 repetitions. After a one-minute rest, the weight was gradually increased, and participants performed 3-5 repetitions. Following a four-minute rest, the weight was increased by 10%, and participants attempted a single repetition. This process continued with three-minute rest intervals until the highest weight successfully lifted was recorded as the 1RM.

In mechanical tension program (MT), participants performed three mechanical-tension sets of preacher curl exercise, using pin-loaded bilateral preacher curl machine (Body-Solid, USA) in the first two weeks. The set was termed "mechanical-tension set" because it was customized to be high-intensity (70%1RM) and maintained throughout the 6-week program to ensure maximum mechanical tension which was the most important stimulus for inducing hypertrophy from each session (Wackerhage et al., 2018). Repetitions were performed to concentric failure to ensure maximal recruitment of muscle fibers to maximizing hypertrophic effect (Ruple et al., 2023). Each set was performed with a fixed repetition tempo of 2 seconds for each contraction phase. The execution rhythm was controlled using a metronome set to a 2-second interval for each contraction phase, ensuring consistent timing and cadence throughout the exercise. 60-second rest between sets was provided. Participants must keep their elbows on the supported pad and were instructed to maintain full range of motion

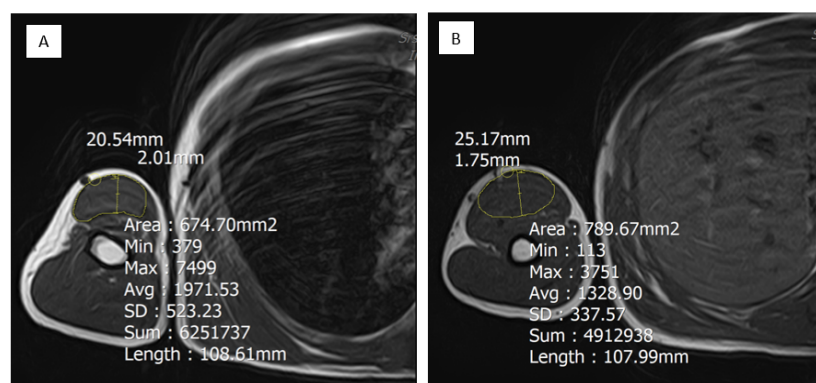
during each repetition. Training volume set was doubled in the third and fourth weeks and increased to eight sets in the fifth and sixth weeks.

In Mechanical tension with metabolic stress program (MTMS), participants performed two mechanical-tension sets at 70%1RM and one metabolic-stress set at 30%1RM with practical blood flow restriction in the first two weeks. The purpose of metabolic-stress set was to induce occlusion of metabolites and local hypoxia of biceps brachii (Schoenfeld, 2013). Therefore, practical blood flow restriction technique was employed to maximizing these metabolic-stress stimulus. Practical blood flow restriction was achieved using elastic wraps (Grizzly Fitness, Canada) fastened at the most proximal of upper arms. Participants were encouraged to fastened elastic wraps to the tightness at least above 40%AOP. Each participant was familiarized with perceived AOP level of their own value by using the adjustable pneumatic cuffs (H+Cuff, USA) before the study began. The training volume set increased similarly, reaching 3 mechanical-tension sets and 3 metabolic-stress sets in the third and fourth weeks, and 4 mechanical-tension sets and 4 metabolic-stress sets in the fifth and sixth weeks. All other training variables remained consistent across both groups.

Regional hypertrophy assessment - All participants underwent assessment for muscle CSA and thickness via MRI and B-mode US of the biceps brachii at 1 week prior to and 1 week after completion of the training program. MRI scans (Vantage Elan, Canon, USA) were conducted by a radiologist using a 1.5-T scanner, which included standard

axial T1-weighted and T2-weighted fat-saturated sequences, as well as coronal T1-weighted and T2-weighted fat-saturated sequences. Muscle CSA measurements were taken at two specific regions: proximal region and distal region, specifically at 50% and 70% of the humerus length (from the acromion process to the lateral humeral epicondyle for the upper arm bone) (Figure 1). Participants were positioned lying supine with their arms extended along their sides during the MRI scans.

Figure 1. Muscle Cross-Sectional Area (CSA) from Magnetic Resonance Imaging (MRI).

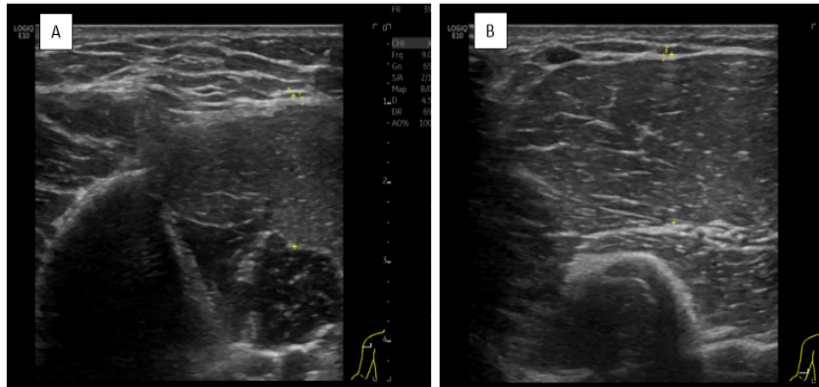


Note. Muscle CSA at proximal region (A) and at distal region (B) of a random participant

For muscle thickness assessment, a US device (LOGIQ E10 Series, GE Healthcare, USA) equipped with a curvilinear probe was used. Measurements were conducted with the participants lying supine, and transmission gel was applied to the skin. The probe, operating at a frequency range of 4-9 MHz, was used to measure muscle thickness at the same points along the humerus: the proximal region at 50% and the distal region at 70% of the humerus length (Figure 2). Additionally, a B-mode US was utilized to measure the fascia thickness above the biceps thickness measurement points to provide further understanding of regional muscle

complex development. All steps were conducted by a certified radiologist.

Figure 2. Muscle Thickness (MT) from Ultrasound Imaging.



Note. Muscle Thickness at proximal region (A) and at distal region (B) of a random participant

Statistical analysis - The statistical analysis was calculated to explore the effects of preacher curl exercise on regional hypertrophy of the two different preacher curl training programs. The Shapiro-Wilk test was used to analyze the normal distribution of data. Descriptive statistics: mean and standard deviation, were used to summarize baseline characteristics. Then, baseline variables between groups were initially compared by One-way ANOVA. Levene's test assessed the homogeneity of variances. Changes in muscle thickness, muscle CSA, and fascia thickness from baseline to Post-test were calculated, with 95% Confidence Interval. A two-way repeated measured ANOVA was employed to compare between-group (MT vs. MTMS) and between-time (Pre vs. Post) effects. In addition to the ANOVA, Paired sample t-tests were conducted to identify within-group differences from Pre to Post for each training program separately, aiming to pinpoint specific changes over time within each group that the ANOVA might not fully

elucidate. Percentage changes and effect sizes were calculated using the formula: mean change /pooled SD, with interpretations based on conventional criteria of 0.00–0.19 was considered as *Trivial*, 0.20–0.49 as *Small*, 0.50–0.79 as *Moderate*, and ≥ 0.80 as *Large* (Cohen, 1992). Statistical analyses were performed using IBM SPSS Statistics version 20, with a significance level set at $\alpha = 0.05$.

3. Results

From total 20 participants, 2 participants had dropped out (1 for loss of interest and 1 for unexpected injury), leaving 8 participants in MTMS and 10 participants in MT. The results were demonstrated in Table 1 that participant characteristics of two groups were not significantly different at baseline.

Table 1. Participants Characteristics

	MTMS (n=8) (mean±SD)	MT (n=10) (mean±SD)	F	p-value
Age (years)	21.3±0.7	21±0	1.270	.276
Height (cm)	173.1±5.5	174.9±5.3	.477	.500
Body mass (kg)	68.5±11.3	69±11.9	.008	.929

Note. Abbreviations: SD= standard deviation, MTMS = Mechanical tension with Metabolic stress program, MT = Mechanical tension program

For muscle hypertrophy, a main time effect was found for muscle thickness at only distal region ($F_{[1,16]} = 40.421$, $p = 0.000$, $\eta^2_p = 0.716$) and for muscle CSA at both proximal ($F_{[1,16]} = 15.358$, $p = 0.001$, $\eta^2_p = 0.490$) and distal regions ($F_{[1,16]} = 38.747$, $p = 0.000$, $\eta^2_p = 0.708$). However, no main effect group or interaction was revealed (Table 2).

Specifically, significant increases in muscle CSA were observed at the proximal region $\Delta 8.26\%$ ($p = 0.038$, ES = *Small*) and $\Delta 9.02\%$ ($p = 0.005$, ES = *Small*) in MT and MTMS, respectively.

Furthermore, more pronounced percentage increases were noted when measuring changes at the distal region, which accounted for $\Delta 12.15\%$ ($p = 0.000$, $ES = Moderate$) and $\Delta 16.92\%$ ($p = 0.008$, $ES = Moderate$) in MT and MTMS, respectively.

sperate analysis revealed only significant increase at distal fascia thickness within MTMS ($\Delta 47.27\%$, $p = 0.006$, $ES = Large$), but not MT ($p = 0.193$). No significant fascia thickness change was observed at the proximal region in both training programs.

Table 2. Muscle Thickness, Muscle Cross-Sectional Area, Fascia Thickness at Pre and Post

	MTMS(n=8)				MT(n=10)				Effect p		
	Pre (mean $\pm$ SD)	Post (mean $\pm$ SD)	Change (95%CI)	d	Pre (mean $\pm$ SD)	Post (mean $\pm$ SD)	Change (95%CI)	d	Group	Time	Interaction
Muscle thickness (cm)											
Proximal	2.20 $\pm$ 0.26	2.33 $\pm$ 0.24	0.13 (-0.07;0.34)	0.53	2.17 $\pm$ 0.27	2.28 $\pm$ 0.15	0.11 (-0.09;0.31)	0.50	0.642	0.070	0.832
Distal	1.93 $\pm$ 0.34	2.35 $\pm$ 0.42 [†]	0.43 (0.15;0.70)	1.10	1.85 $\pm$.20	2.33 $\pm$ 0.27 [†]	0.48 (0.28;0.67)	1.96	0.76	0.000	0.709
Muscle cross-sectional area (mm²)											
Proximal	723.63 $\pm$ 128.53	788.88 $\pm$ 164.46 [†]	65.25 (26.45;104.04)	0.44	772.60 $\pm$ 131.96	836.40 $\pm$ 146.15*	63.80 (4.40;123.19)	0.46	0.474	0.001	0.965
Distal	797.75 $\pm$ 197.32	932.75 $\pm$ 190.68 [†]	135 (48.88;221.12)	0.70	843.10 $\pm$ 136.89	945.50 $\pm$ 168.13 [†]	102.40 (61.69;143.11)	0.66	0.721	0.000	0.405
Fascia thickness (mm)											
Proximal	0.71 $\pm$ 0.20	0.76 $\pm$ 0.18	0.04 (-0.07;0.05)	0.26	0.70 $\pm$ 0.30	0.87 $\pm$ 0.14	0.17 (-0.10;0.44)	0.69	0.543	0.152	0.416
Distal	0.55 $\pm$ 0.20	0.81 $\pm$ 0.17 [†]	0.26 (0.10;0.42)	1.40	0.64 $\pm$ 0.17	0.73 $\pm$ 0.14	0.09 (-0.05;0.23)	0.57	0.955	0.002	0.085

Note. Abbreviations: SD= standard deviation, MTMS = Mechanical tension with Metabolic stress program, MT = Mechanical tension program, ES = Effect size. d = Cohen's d effect size. * $p < 0.05$ compared to Pre, † $p < 0.01$ compared to Pre. and 95% Confidence Interval.

Besides, the assessment of muscle thickness revealed a significant increase in muscle thickness at only the distal region of the biceps brachii in both groups. The significant increases of muscle thickness at the distal region were $\Delta 25.95\%$ ($p = 0.000$, $ES = Large$) and $\Delta 21.76\%$ ($p = 0.009$, $ES = Large$) in MT and MTMS, respectively. However, no significant increases were observed at the proximal region in both programs.

Furthermore, the findings regarding fascia thickness revealed a main time only at distal region ($F_{[1,16]} = 14.076$, $p = 0.002$, $\eta^2_p = 0.468$). No main effect group or interaction was revealed at any region. However, the

4. Discussion

This current study provided strong evidence for regional hypertrophy, particularly showing how the preacher curl exercise affected the biceps brachii muscle. We found that performing the preacher curl for six weeks, with progressive volume, predominantly increased hypertrophy in the distal region of the biceps brachii. The strength of this study was supported by consistent observations of increased muscle CSA measured by MRI and muscle thickness measured by US. Additionally, our investigation indicated that different resistance training programs did not significantly alter the specific hypertrophic

patterns induced by the exercise. Both experimental groups showed similar distal biceps hypertrophy, regardless of the hypertrophic stimuli used.

The hypertrophic outcomes observed in our study aligned with previous research findings. For instance, Zabaleta-Korta et al. (2023) reported a significant increase in muscle thickness following a 9-week regimen of preacher curl exercise in recreationally trained women. Their study demonstrated a notable increase in muscle thickness from 2.68 cm to 2.94 cm, representing a 9.7% increase ($p = 0.017$, $d = 0.62$) in the distal region. Comparing to our findings, the relatively larger percentage increase observed in our investigation, which might be attributed to the untrained status of our participants, as novice practitioners often experience substantial initial gains in response to training (Arntz et al, 2022). Moreover, they also reported that the proximal region of the biceps brachii showed only a slight, non-significant increase (6.6%, $p = 0.347$). The percentage increase in Zabaleta-Korta's study was surprisingly close to the findings in our study, at 5.1% ($p = 0.254$) in HT and 5.9% ($p = 0.156$) in MTMS in the proximal region of the biceps brachii, supporting the lesser effectiveness of preacher curl exercise in inducing proximal hypertrophy.

Additionally, a previous study investigated how adjusting the range of motion affects muscle hypertrophy (Pedrosa et al., 2023). Healthy participants were instructed to train three times a week, and the researchers found that focusing on preacher curls within a specific range of motion, from 0 degree to 68 degree of elbow flexion, led to more significant distal hypertrophy ($d = 0.89$) compared to training at 68 degrees to 135 degrees of elbow flexion ($d = 0.23$). In our study, we also employed a full range of motion as a controlled variable, ensuring all repetitions passed through 0-68 degrees of

elbow flexion, suggesting a potential correlation with these findings. Moreover, the evidence of training at more stretched position to induce distal hypertrophy was supported by McMahon et al. (2014). The researchers found that this approach was also applicable to leg muscles, demonstrating that distal vastus lateralis hypertrophy was greater when exercises like split squats and leg presses were performed at a larger range of motion.

Besides, the recent study by Nunes et al. (2020) investigated how preacher curl exercise performing with cable pulley or free-weight resistance affected muscle growth. After 10-week training, they observed approximately 2mm increase ($d = 0.35-0.37$) in the biceps brachii at 50% of the humerus length, matching our proximal region. Interestingly, our own findings echoed these findings, demonstrating 1.3mm increase ($d = 0.53$) in MTMS and a 1mm increase ($d = 0.50$) in MT at proximal region, regardless of training programs. Nunes' study likely achieved higher hypertrophy due to longer training duration and frequency. Nevertheless, they did not assess muscle growth at the distal region, making a direct comparison of regional hypertrophy challenging at distal region.

In contrast, our study's results differed from those of Drummond et al. (2016), who found that after 12 weeks of dumbbell preacher curl training, uniform biceps brachii hypertrophy was observed in untrained participants. Their findings demonstrated a significant increase in muscle CSA of the biceps brachii, with approximately 20% increase in the proximal region and 18% increase in the distal region, as evaluated via MRI. The discrepancy in results may be attributed to differences in measurement methods. Our current study identified muscle regions based on anatomical humerus length, whereas Drummond's study used the first, middle, and last MRI

slices of MRI to represent the proximal, middle, and distal regions.

From a mechanistic standpoint, Oliveira et al. (2009) provided evidence that the preacher curl exercise induced the highest levels of muscle activation as assessed via electromyography, particularly at the onset of the concentric phase, with muscle resting in stretched position. Additionally, compared to the standing dumbbell curl, muscle activation during the latter stages of the eccentric phase was significantly elevated. This suggested that the biceps brachii muscle was maximally engaged when stretched, potentially contributing to regional distal hypertrophy.

Furthermore, Nosaka and Sakamoto (2001) found that reaching maximal extension (elbow straight) during the eccentric phase of the preacher curl caused more muscle damage than keeping the eccentric phase shorter. From hypertrophic standpoint, it was previously proposed in the mechanisms of hypertrophy that muscle damage, along with mechanical tension and metabolic stress, was another potential stimulus for inducing muscle hypertrophy (Schoenfeld, 2010). Therefore, it was possible that the preacher curl exercise, by maximizing muscle activation and inducing muscle damage during the eccentric phase, could be particularly effective for promoting muscle distal hypertrophy.

Besides, previous study further indicated that training muscles at extended lengths could potentially lead to an increase in sarcomere length (Wisdom et al., 2015). This extension of muscle structure might promote additional muscle growth particularly in the distant region. This phenomenon commonly referred to as stretch-mediated hypertrophy (Warneke et al., 2023). This was supported by the previous study that had found that following exercising at extended muscle lengths, for example, there was the significant increase in fascicle length of vastus lateralis muscle

($\Delta 4.9\%$, $p = 0.001$, $d = 0.70$) after knee extension exercise which engaged higher degree of knee flexion during eccentric quadriceps contraction (Valamatos et al., 2018).

In addition, the significant increase in fascia thickness was observed at the distal region of biceps brachii ($p < 0.05$) in MTMS, indicating remodeling of the fascia in response to the training stimulus (Schleip et al., 2012). Conversely, in MT, no significant increase in fascia thickness was observed at either region. Regarding potential mechanisms, the effects of practical blood flow restriction on fascia remodeling may involve local hypoxic factors, such as hypoxia inducible factor (HIF). Previous research has highlighted how blood flow restriction induced localized hypoxia within working muscle tissue, consequently activating HIF pathways and various cellular responses to low oxygen levels (Torpe et al., 2018). This activation of HIF signaling pathways could prompt adaptive changes in fascial thickness and collagen composition (Valle-Tenney et al., 2020). Although our study did not deeply explore molecular level changes in collagen content expression during training sessions, existing literature showed the responses of collagen-related molecular markers following resistance exercising (Hjorth et al., 2015; Mackey et al., 2004; Moore et al., 2005). Additionally, cells within the fascia layer, such as satellite cells, are pivotal in muscle repair and regeneration (Johnson et al., 2023). Thus, we suggested that the process of fascia remodeling might significantly link to enhancing satellite cell function and the overall adaptive capacity of skeletal muscle.

Last but not least, the findings of this study supported the thought process of hypertrophy program design, that practitioners aiming to maximize muscle growth across all regions of a muscle should incorporate multiple exercises targeting the muscle (Baz-Valle et al., 2019). Our results revealed that exclusively performing preacher curls may not fully optimize the size

of the proximal region of the biceps brachii. Costa et al. (2021) similarly demonstrated that incorporating a variety of exercises, such as standard biceps curls, preacher curls, and inclined dumbbell curls, across training sessions resulted in superior absolute increases in the percentage of muscle regional hypertrophy across proximal, middle, and distal regions.

This was further reinforced by previous studies which showed that engaging in various exercises targeting a specific muscle led to different patterns of muscle activation, potentially contributing to hypertrophy across various regions of the muscle (Finni et al, 2008; Wakahara et al., 2013). Furthermore, another work by Zabaleta-Korta et al. (2021) demonstrated about the role of various exercises, such as smith machine squats and leg extensions, leading to distinct regional hypertrophy in the legs. Their findings showed that even with identical volume and intensity protocols, both exercises produced different patterns of muscle growth. Specifically, squats led to more significant increases in the vastus lateralis, while leg extensions primarily enhanced the rectus femoris. This indicated that different exercises targeted muscle growth in different areas.

Thus, we proposed that future research should explore other specific exercises on regional hypertrophy, with a focus on identifying elbow flexor exercise that promoted greater growth in the proximal region. This information could inform the development of training protocols, designed to maximize biceps brachii hypertrophy by strategically pairing exercises such as the preacher curl with those targeting the proximal region. Moreover, this study utilized a relatively small sample size, determined based on an effect size of 0.75 as reported by Zaroni et al. (2019). However, it was important to acknowledge that effect sizes could vary across different studies. This variability could potentially influence the outcomes and generalizability of the

findings. Therefore, future studies should consider the potential variability in effect sizes when designing their sample sizes and interpreting the results.

5. Practical Applications.

This study demonstrated that performing the preacher curl exercise effectively promoted regional hypertrophy, particularly in the distal region of the biceps brachii. However, it was important to note that since these participants did not have a regular resistance training routine, their initial trainability might have influenced the observed outcomes. Moreover, we suggested that relying solely on preacher curls might result in suboptimal hypertrophy of the proximal region of the biceps. Practitioners aiming to design comprehensive training programs for complete biceps brachii development should incorporate preacher curls alongside other curl variations to ensure balanced and maximal muscle hypertrophy.

6. Conclusions

In conclusion, this study demonstrated that biceps brachii regional hypertrophy was affected by the selected exercise per se, but not resistance training programs. Preacher curl exercises were found to particularly promote hypertrophy in the distal region of the biceps brachii. Further research into the effects of specific exercises, such as those targeting the proximal region of the biceps brachii, as well as other muscle groups, is warranted to inform the development of more effective hypertrophy program designs.

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