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Effects of Band-Resisted Abduction on Muscle Activity between the Barbell Hip Thrust and Barbell Glute Bridge

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ABSTRACT

The importance of hip extensor and abductor muscles for sprint-running speed in sport performance and injury reduction during forceful landing is well-documented. To target these muscle groups, the barbell hip thrust and barbell glute bridge are used to load the posterior kinetic chain while band-resisted abduction exercises, like band-resisted side stepping, target the lateral kinetic chain. However, combining band-resisted hip abduction with barbell hip-extension dominant exercises has not yet been investigated. In this study, twelve male subjects (age = 20.3 ± 1.1 years; height = 184.6 ± 6.9 cm; body mass = 86.8 ± 16.7 kg) with 6.0 ± 2.2 years of resistance training experience underwent a two-part research protocol with surface electromyography (sEMG) measured during a 5-repetition maximum (5-RM) load performance to determine differences in peak and mean muscular activity between barbell hip thrust (BHT) and band-resisted barbell hip thrust (BBHT), and between barbell glute bridge (BGB) and band-resisted barbell glute bridge (BBGB). Repeated measures ANOVAs were conducted to examine mean differences of sEMG activity between BHT and BBHT, BGB and BBGB. The results indicated four significant differences between the pairs. Both band-resisted conditions elicited greater mean sEMG activity in the upper gluteus maximus compared to non-banded conditions, and BBHT elicited greater peak sEMG activity in the upper gluteus maximus compared to non-banded conditions. However, BGB unexpectedly elicited greater sEMG activity in the gluteus medius compared to BBGB. The differences in muscle activity could potentially be explained by reciprocal inhibition and synergistic dominance. Further research is needed to make definitive statements on the superiority of band-resisted barbell exercises over non-banded barbell exercises and transferability to sport performance.

Keywords: synergistic dominance; reciprocal inhibition; elastic fabric resistance bands; hip extension; hip abduction

INTRODUCTION

The importance of hip extensor performance in athletic movements, such as sprint-running speed and force absorption during landing tasks, is well documented (3,40,42,43). However, the involvement of the hip extensor muscles is diminished in such activities if underdeveloped (3,42,43). Subsequently, situations may be created where an individual is more likely to underperform and/or be more prone to knee injuries or lower back pain (24,29,32). The hip extensors are a well-studied group of agonistic muscles comprised of primary and secondary extensors and are an important link in the posterior kinetic chain. The classification of a muscle within a specific class, primary or secondary, is based on its potential to produce a particular action due to factors including moment arm length, cross-sectional area, or muscle torque (36). The primary group is composed of the gluteus maximus (GMax), adductor magnus (posterior head), biceps femoris (long head; BF), semitendinosus, and semimembranosus (36). While the middle and posterior fibers of the gluteus medius (GMed) and the anterior head of the adductor magnus are considered a part of the secondary extensor group, all fibers of the GMed, and gluteus minimus (GMin), are considered primary hip abductors, also known as the lateral kinetic chain (17,36). Weak or dysfunctional hip abductors (specifically the GMed) are also associated with several disorders, including patellofemoral pain syndrome, anterior cruciate ligament (ACL) injury, ankle joint injury, and low back pain. These are common injuries within sport (1,6,31,38).

Undesirable movement patterns due to muscular weakness or dysfunction that may contribute to injury potential can be decreased through proper exercise selection focusing on specific musculature along the posterior and lateral kinetic chains (1,42,43,49). External load is recommended for the development of the hip extensor muscles, as body weight exercise may not be sufficient to elicit positive strength changes within the targeted musculature (12,47). The barbell hip thrust (BHT) and barbell glute bridge (BGB) were developed as biomechanically efficient movements to load the musculature of the posterior kinetic chain, while band-resisted abduction exercises, like resisted side stepping, have been utilized in isolation to target the hip abductors, a significant contributor to the lateral kinetic chain (14,26,30,37). Previous research has indicated band-resisted abduction exercises may be beneficial for the development of the GMed and GMin, as lower body exercises alone may not be enough to increase the cross-sectional area of the GMed and GMin (18). Recently, a trend has developed combining band-resisted abduction with hip and knee extension exercises to target all three heads of the gluteal complex simultaneously during compound movements to accommodate time restrictions on training. Combining band-resisted abduction with hip or knee extension exercises would, hypothetically, facilitate the development of both the posterior and lateral musculature simultaneously while reducing overall time spent within the weight room.

Introducing multiple planes of resistance into an exercise is not a new concept. Band-resisted hip abduction has been well studied in knee extension dominant (KED) exercises, like the body-weight (BW) and barbell squat variations (19,21,39,41). Band-resisted hip abduction research has been further explored in BW hip extension dominant (HED) exercises, demonstrating similar outcomes of increased gluteal activity (4,37,48). However, the outcomes of increased gluteal muscle complex activity should not be extrapolated to barbell variations of HED exercises since previous research has demonstrated that the barbell back squat (a KED exercise) exhibits lower levels of muscular activity in the GMax and BF when compared to BHT (a HED exercise) (15). Research has further indicated differences in GMax muscle activity exists on a sub-sectional level (upper gluteus maximus (UGMax) and lower gluteus maximus (LGMax), within barbell variations of HED exercises like the BHT and BGB (26). With indications that band-resisted abduction and HED exercises are superior in eliciting an increased activity in the GMax and GMed musculature separately, it is noteworthy that the combination of the two into a multi-plane barbell resistant exercise has not been investigated (15,18,26,30). Therefore, the purpose of this study was to determine if differences are present in lower body muscular activity between band-resisted abduction BHT (BBHT) and BHT, and band-resisted abduction BGB (BBGB) and BGB at 5-repetition maximum (5-RM). It was hypothesized the BBHT and BBGB would elicit significantly greater UGMax and GMed activity than the BHT and BGB, with no differences in LGMax or BF activity between the two groups.

METHODS

Experimental Approach to the Problem

To conduct this study, a four site surface electromyography (sEMG) was utilized to record electrical muscular activity of the UGMax, LGMax, GMed, and BF. Following the protocol of previous research (2,16,20,23,26), the sensor location and positioning of the sEMG were directly over the 'belly' of the muscle. The electrical muscular activity was measured during a 5-RM performance for all four exercise conditions: BHT, BBHT, BGB, and BBGB. This load was selected to replicate previous research (26). Exercise load was normalized for each exercise to account for the effects of multiple planes of resistance and the presence of biomechanical and limb position variations on muscular activity (19,26,39,48). Foot position was standardized to the shoulder width of each subject, as noted in previous research (26), to further standardize the exercise set-up. For the BBHT and BBGB, the BC Strength Glute Loop™ Level 1 size L/XL was selected to provide resistance in the frontal plane, maintain position, and avoid band slippage. The band was placed around the distal thigh, proximal to the lateral epicondyle of the femur in accordance with Spracklin et al. (41) (Figure 1A & 2A). As previously mentioned, the sEMG activity of the three lower body muscles (GMax, GMed, and BF) were recorded while 12 subjects performed a 5-RM protocol for each exercise (BHT, BBHT, BGB, and BBGB) in a randomized order. Adequate rest time (a minimum of five minutes) was allotted for each subject between each testing condition for recovery and optimal performance. Two testing sessions were required from each subject to record all meaningful data. A Certified Strength and Conditioning Specialist supervised each testing session as they were conducted to ensure proper exercise technique was performed and the sessions were separated by a minimum of 72 hours. If possible, subjects were tested at the same time of day on each testing occasion.

Subjects

A minimum of 12 subjects were needed, determined through an a priori power analysis conducted with G*Power 3.1.9.7 (Universitat Kiel, Germany), for the repeated measures ANOVA with power of 0.80, an $\alpha = 0.05$, and with an effect size of 1.0, which was similar to the effect sizes achieved by Kennedy et al. (26). Twelve healthy male subjects (age = 20.3 ± 1.1 years; height = 184.6 ± 6.9 cm; body mass = 86.8 ± 16.7 kg; shoulder span = 46.0 ± 2.3 cm) were recruited for the purpose of this study. Subjects in the study met a minimum requirement to be classified as "experienced lifters", all having at least one year of strength training experience, per the American College of Sports Medicine 2009 Position Stand (27). Subjects had 6.0 ± 2.2 years of resistance training experience. Further, in relevance to this study, the subjects' strength training experience specifically included the BHT and/or BGB movements. Other inclusion criteria included: the capacity to proficiently perform a 5-RM BHT and BGB with a minimum load of 50% body weight (BW); a minimum age of 18 years; an ability to abstain from any rigorous exercise while maintaining usual diet in the 24-hours before both training sessions; a self-determination of being healthy and free from any: injuries (for at least 3 months), physical discomfort, pain, or sickness, and prior surgeries that might interfere with their ability to execute the BHT or BGB movements. All subjects were given a verbal explanation of study protocol, purpose, and risks/benefits of participation. Prior to testing, signed informed consent documents were acquired from the subjects. The study was approved (IRB# 2020.12.002) by the West Texas A&M University Institutional Review Board.

Procedures

Session 1

First session procedures included: the measurement and recording of subject anthropometrics; a determination of subject's 5-RM of the BHT, BBHT, BGB, and BBGB; and subject familiarization with the maximum voluntary isometric contraction (MVIC) testing protocol. Subjects also underwent a dynamic movement warm-up protocol followed by an exercise-specific warm-up in preparation for establishing their 5-RM for the randomly ordered BHT, BBHT, BGB, and BBGB.

A standardized procedure was used to find the 5-RM that was replicated from previous research (26). Subjects were first instructed to complete two warm-up sets. They then had five attempts to find a 5-RM (26). After each completed five-rep set, a three-to-five-minute rest was taken and on each subsequent attempt, a five to 25 lbs. weight increase occurred. Testing ceased when the subject was unable to complete the designated exercise with the appropriate form. After 5-RM's were determined for the four movements, subjects were familiarized with MVIC testing procedures and skin preparation protocols.

As presented in Figure 1A & 1B, the subjects were instructed to perform the BHT and BBHT protocol as described in previous research (26) to ensure conformity across all recorded trials. To standardize exercise set up and foot placement across subjects and trials, a 35.5-cm bench height and a measured 90° knee flexion angle at the end point of the BHT was sought to determine appropriate distance of foot placement, in conjunction with the standardized width, before to performing the exercise. For the BBHT, the BC Strength Glute Loop™ level 1 size L/XL was placed around the distal thigh, proximal to the lateral epicondyle of the femur with the knee with the logo facing outward prior to set up and performance to ensure set-up conformity was maintained with the addition of abduction resistance (41). Barbell hand placement was in a supinated grip with shoulders externally rotated, allowing for barbell stability throughout the movement positions (26).

As pictured in Figure 2A & 2B, the BGB and BBGB incorporated the same set-up procedures as the BHT and BBHT, however, with differing torso position and knee angle. To standardize the BGB and BBGB set-up, the protocol from Kennedy et al. (26) was followed. Like the BBHT, the BC Strength Glute Loop™ level 1 size L/XL was placed in the same position to ensure conformity. No retrials were actualized during data collection given that upper body shifting, or movement, did not occur.

Session 2

The second data collection session began with the same standardized dynamic warm-up and exercise-specific warm-up as session one. The standardized exercise-specific warm-up was determined by the exercise that was randomly selected to be performed first for data collection. The previously established 5-RM's were converted to a 1-repetition maximum (1-RM) by dividing the 5-RM by 87% (26). Based off the 1-RM, an exercise-specific warm up was replicated and performed (26). A three-to-five-minute rest was taken after each set.

After the warm-ups, the subject's skin was primed to ensure ample conductivity for the sEMG electrodes. The protocol included: removing debris and hair using shaving cream and a razor; abrasion via light rubbing of mild sandpaper; cleaning of skin surface with rubbing alcohol and cotton swab; and drying of the surface area where electrodes would be attached, which consisted of four muscle sites and a ground (23). The ground was placed on the fibular head or another bony prominence. On the prepared skin of the dominant leg, self-adhesive disposable silver/silver chloride pre-gelled dual-snap surface bipolar electrodes (Noraxon Product #272, Noraxon USA Inc., Scottsdale, AZ) with a diameter of 1 cm and an inter-electrode distance of 2 cm were positioned in parallel to the fibers at each muscle site.

After sEMG electrodes application, and 10 mins after the last warm-up set, MVIC testing was performed. Once baseline sEMG measurements were ascertained, and after a five minute rest, 5-RM testing was performed for the BHT, BBHT, BGB, and BBGB at the pre-established 5-RM for each exercise. After subjects were placed in their standardized starting positions with a protective bar pad for comfort, the four exercises were carried out in full range of motion (barbell starting on the floor to a neutral hip position 0° of extension). During the BBHT and BBGB, subjects were instructed to "break the band" as the hip extended to a neutral position of 0°. This was done to ensure multiple planes of motion and resistance were occurring simultaneously. As demonstrated in Collazo et al. (13), Contreras et al. (15), and Kennedy et al. (26), a predetermined tempo was not implemented for the exercises allowing for a self-selected pace.

Data Collection

Raw sEMG signals for the four electrode sites were collected at 1500 Hz via TeleMyo DTS EMG sensors (Noraxon USA Inc., Scottsdale, AZ). sEMG to computer data transmission was done via Bluetooth by a TeleMyo DTS Desk Receiver (Noraxon USA Inc., Scottsdale, AZ) to be recorded and analyzed by MyoResearch 3.8 Clinical Applications software (Noraxon USA Inc., Scottsdale, AZ). Measurement of sEMG activity in the three selected muscles (GMax, GMed, and BF) was done on the dominant leg (identified on informed consent as leg with which subject would kick a ball) in session 2 during 5-RM testing. sEMG electrodes for the UGMax, LGMax, GMed, and BF were placed in accordance with Kennedy et al. (26).

Baseline sEMG measurements during MVIC were randomized. Electrical activity during MVIC was measured in the GMax in the prone position with the knee flexed to 90° against a strap to standardize resistance applied against the posterior distal femur (5) and the standing glute squeeze (16). With previous research (16) showing that neither of the two positions produce higher peak electromyographic activity, both conditions were tested and the position that elicited the greatest electromyographic activity was used as the representative value of MVIC after normalization. GMed and BF baseline MVIC activity was collected using the protocols demonstrated in Kennedy et al. (26).

Kennedy et al.'s (26) MVIC protocol was used. Raw signals of MVIC testing and 5-RMs for the BHT, BBHT, BGB, and BBGB underwent post processing. For MVIC testing, signals were filtered through a 10 to 500 Hz bandpass filter, processed through full-wave rectification, smoothed to a root mean square (RMS) with a 100-ms window, and amplitude was normalized to a mean peak window of 1000-ms. Once post processing was completed for MVIC testing, the 5-RMs for each of the four exercises underwent the same processing, and amplitude was normalized to the mean peak determined from MVIC post-processing.

Figure 1A & 1B. (1A) Band-resisted Barbell Hip Thrust (BBHT) starting position. (1B) BBHT end position.

Figure 2A & 2B. (2A) Band-resisted Barbell Glute Bridge (BBGB) starting position. (2B) BBGB end position.

Statistical Analysis

In accordance with Kennedy et al. (26) and Collazo et al. (13), repetitions two, three, and four of the 5-RM protocol were averaged, omitting the first and fifth repetitions from the analysis. Repeated measures ANOVAs were completed with SPSS® 28.0 (IBM Corporation, Armonk, NY, USA) for Windows®/ AppleMac®. Mauchly test for sphericity and Shapiro-Wilk test for normality were examined before conducting the ANOVAs. Bonferroni correction was applied to post hoc pairwise comparisons to control for type-1 error. Cohen's *d* effect sizes (ES) were computed using the formula M_D/SD_D. Alpha levels were set at .05 for statistical significance in all analyses. The mean ± standard deviation (SD) and confidence intervals (95% CI) were calculated for all trials.

RESULTS

As presented in Table 1 and Table 2, results indicated four pairwise comparison mean differences were found to be statistically significant. BBHT elicited significantly greater sEMG activity than BHT for peak outcomes in the UGMax (*M*Δ = -12.28; *SE* = 2.98; *ES* = -0.83, 95% CI [-1.48, -0.16]). BBHT elicited significantly greater sEMG activity than the BHT for mean outcomes in the UGMax (*M*Δ = -16.56; *SE*= 5.74; *ES* = -1.19, 95% CI [-1.92, -0.42]). BBGB elicited significantly greater sEMG activity than the BGB for mean outcomes in the UGMax (*M*Δ = -11.03; *SE* = 3.07; *ES* = -1.04, 95% CI [-1.73, -0.31]). BGB elicited significantly greater sEMG activity than the BBGB for mean outcomes in the GMed (*M*Δ = -16.56; *SE* = 5.74; *ES* = 0.74, 95% CI [0.84, 1.37]).

DISCUSSION

The purpose of this study was to determine if any differences were present in peak and mean muscular activity between the BHT and BBHT, and between the BGB and BBGB. Results indicated significant differences were present in four of the pairs confirming part of the hypothesis. Mean outcomes, which produced a large effect size, demonstrated the BBHT elicited significantly greater muscle activity of the UGMax than the BHT, and the BBGB elicited significantly greater muscle activity of the UGMax than the BGB. In contrast to the hypothesis, and

Table 1. Pairwise Comparison Mean Differences of peak (± SD) sEMG activity (% MVIC) of Hip Extensor Musculature between BHT and BBHT, BGB and BBGB.

		Peak				
Muscle	**BHT**	**BBHT**	***p*[a]**	**BGB**	**BBGB**	***p*[a]**
UGMax	107.47±24.91	124.03±29.20	**.015**	123.14±37.07	131.08±31.59	.214
LGMax	112.65±26.84	117.74±38.44	.402	126.65±32.98	128.54±43.65	.791
GMed	128.93±19.73	127.66±21.87	.860	138.67±24.41	129.56±22.17	.130
BF	103.34±32.97	102.08±27.63	.835	101.43±34.42	95.03±28.33	.342

Note. sEMG = surface electromyography; BHT = barbell hip thrust; BBHT = band-resisted barbell hip thrust; BGB = barbell glute bridge; BBGB = band-resisted barbell glute bridge; UGMax = upper gluteus maximus; LGMax = lower gluteus maximus; GMed = gluteus medius; BF = biceps femoris

[a]*Bonferroni adjusted p-value for multiple comparisons*

Table 2. Pairwise Comparison Mean Differences of mean (± SD) sEMG activity (% MVIC) of Hip Extensor Musculature between BHT and BBHT, BGB and BBGB

		Mean				
Muscle	**BHT**	**BBHT**	***p*[a]**	**BGB**	**BBGB**	***p*[a]**
UGMax	50.35±16.88	62.63±18.52	**.002**	62.62±21.51	73.65±18.82	**.004**
LGMax	52.16±13.15	60.63±22.09	.100	63.30±18.99	64.47±22.18	.623
GMed	54.44±9.35	51.69±9.98	.334	71.45±15.95	63.33±13.94	**.026**
BF	46.39±17.76	46.11±18.31	.907	51.89±18.38	46.18±16.60	.141

Note. sEMG = surface electromyography; BHT = barbell hip thrust; BBHT = band-resisted barbell hip thrust; BGB = barbell glute bridge; BBGB = band-resisted barbell glute bridge; UGMax = upper gluteus maximus; LGMax = lower gluteus maximus; GMed = gluteus medius; BF = biceps femoris

[a]*Bonferroni adjusted p-value for multiple comparisons*

with a large effect size, the BGB elicited significantly greater muscle activity of the GMed than the BBGB for mean outcomes. No statistically significant differences were observed for mean outcomes in the GMed for the BHT:BBHT group. Peak outcomes, which produced a large effect size, demonstrated the BBHT elicited significantly greater muscle activity of the UGMax than the BHT. No statistically significant differences were observed in any peak outcomes, or in mean outcomes for the LGMax and BF.

Unlike what was demonstrated in previous research (19,41), the integration of an additional plane of resistance, band-resisted abduction, inhibited the total amount of load that was able to be moved during the BBHT and BBGB variations compared to BHT and BGB in the present study. It is assumed maximal intent of extension and abduction of the hip were applied simultaneously during band-resisted exercise variations. However, the difference in 5-RM load could raise questions when compared to sEMG amplitudes. Between the two conditions of band-resisted and non-banded, there were no significant differences in muscle activity between the LGMax and BF, although differences in external load differed by an average of 12.2% within each group (BHT:BBHT, BGB:BBGB). It is well documented that increases in sEMG amplitudes are dependent on numerous variables including increases in muscle fiber recruitment, motor unit firing frequency, or peripheral factors (28,45,46). While muscle activity does increase with external load, it does not occur in a linear fashion as it is muscle and load (percentage of 1-RM) dependent (34,44). This hypothesis can be further observed if BHT and BGB 5-RM are converted into 1-RM (5-RM load divided by 87%) (26), then the recorded 5-RM loads of each exercise (BHT, BGB, BBHT, BBGB) are compared within each of their respected groups as a percentage of load to the non-banded 1-RM (5-RM BHT and 5-RM BBHT compared to estimated 1-RM BHT; 5-RM BGB and 5-RM BBGB compared to estimated 1-RM BGB). The difference in load between the band-resisted and non-banded 5-RM compared to an estimated non-banded 1-RM is approximately 10% (Table 3 & Table 4). Similar to Tillaar et al. (44), percentage of 1-RM loads being within 10% of each other yields similar sEMG results. Minor difference in overall load could explain the absence of statistically significant differences in muscle activity between the LGMax, and BF although loads were equated at 5-RM. Therefore, extrapolating the results in this data set to make definitive statements of superiority for band-resisted barbell exercises over non-banded barbell exercises, or vice versa, should be avoided as further investigation is needed.

The statistically significant differences in UGMax muscle activity in the BBHT and BBGB were aligned with the research hypotheses. Contrary to the hypotheses, statistically significant differences in GMed muscle activity were observed in the BGB compared to the BBGB. These unexpected observations can be addressed and best described using two different, yet related concepts, known as reciprocal inhibition and synergistic dominance.

Reciprocal inhibition is a hypothetical relationship between agonist and antagonist muscle groups that suggests that a balance between muscle length and strength (Length-Tension Relationship) must be

Table 3. Differences in body mass (kg), 1-RM load (kg), and 5-RM load (kg) between participants for the BHT and BBHT

Participant	BM	1-RM BHT	5-RM BHT	1-RM BBHT	5-RM BBHT
Mean	86.8	167.8	146.0	150.2	130.7
SD	16.7	32.6	28.4	27.3	23.7
SE	4.8	9.4	8.2	7.9	6.9

Note. 1-RM = estimated one repetition maximum; 5-RM = five repetition maximum; BHT = barbell hip thrust; BBHT = band-resisted barbell hip thrust; BM = body mass

Table 4. Differences in body mass (kg), 1-RM load (kg), and 5-RM load (kg) between participants for the BGB and BBGB

Participant	BM	1-RM BGB	5-RM BGB	1-RM BBGB	5-RM BBGB
Mean	86.8	178.7	155.5	156.3	136.0
SD	16.7	34.4	30.0	32.2	28.1
SE	4.8	9.9	8.6	9.3	8.1

Note. 1-RM = estimated one repetition maximum; 5-RM = five repetition maximum; BGB = barbell glute bridge; BBGB = band-resisted barbell glute bridge; BM = body mass maintained to avoid inhibition of the agonist muscle group (e.g., hip flexor muscle group tightness, gluteus maximus weakness) (8,22,35). Synergistic dominance is the increased reliance on another primary class agonist muscle group due to weakness or restriction of the predominant primary class agonist muscle group (e.g., hamstrings compensate for gluteus maximus) (7–9,22,35). When reciprocal inhibition is presented, neuromuscular dysfunction is hypothesized to occur triggering a movement syndrome, often associated with muscular imbalances, leading to alterations of neuromuscular activity surrounding a joint. Those alterations in neuromuscular activity may result in synergistic muscles becoming overactive to compensate for weak or inhibited prime movers (i.e., synergistic dominance) (7–9,34,35).

Both concepts were potentially demonstrated between the UGMax and GMed (synergistic dominance), and the GMed and adductor muscle group (reciprocal inhibition). McAndrew et al. (33) hypothesized segmental differences within the GMax musculature (cranial (UGMax); middle; caudal (LGMax)) and function. The cranial section of the GMax (the UGMax in relation to this study) functioned more as an abductor like the GMed than as an extensor like the caudal (LGMax) fibers. A conclusion could be interpreted as the UGMax is acting as a synergistic hip abductor while the LGMax a primary hip extensor. When band-resisted abduction was introduced to the BHT and BGB, it may have inadvertently induced reciprocal inhibition. By restricting the length of the adductor muscle group through band-resisted abduction, inhibition in GMed muscle activity was observed. However, hip abduction still needed to be performed for these exercises and was accomplished through synergistic dominance. Due to the restriction of the adductor muscle group and GMed activity, significant increases in muscle activity of the UGmax were observed in the BBHT and BBGB. To further support the case for GMax segmentation, reciprocal inhibition, and synergistic dominance, the BGB demonstrated statistically significant increases in GMed activity when compared to the BBGB. Furthermore, no observable differences in LGMax or BF (synergistic muscle groups) activity were demonstrated, as neither muscle group was restricted. Future research should further investigate muscle segmentation within the GMax and the roles reciprocal inhibition and synergistic dominance play in longitudinal muscle development.

Limitations of this study should be taken into consideration when interpreting the results. Due to the homogeneous sample, consisting of only highly trained male subjects, further investigation is warranted for additional populations, such as females, elderly, and untrained subjects. Another limitation of this study was in the BBHT and BBGB conditions that utilized the BC Strength Glute Loop™ level 1 size L/XL, of which tensile strength was not measured or calibrated. Given the lack of research on elastic fabric resistance bands, further investigation is warranted to establish the effect of different tensile strengths on sEMG for multi-plane barbell resistant exercises. Furthermore, stance width was standardized to shoulder span to create an approximate abduction angle of 30°, and maximum abduction effort was assumed. Future research should measure hip abduction angles and forces, as 30° of hip abduction elicits significantly greater muscle activity of the GMax than lesser abduction angles (10,11,25). This would help reduce hip abduction angle discrepancies in both band-resisted and non-banded conditions, and distinguish which condition produces greater force. Lastly, the bench height for the BHT and BBHT was kept constant in the current study. Future research should standardize bench height for each subject based on their torso height to allow the bench to sit below the inferior angle of the scapula.

CONCLUSION

The development of specific posterior and lateral kinetic chain musculature is critical in reducing the likelihood of lower body injuries (1,3,6,9,24,29,31,32,38,42,43). Combining band-resisted abduction with HED exercises would, hypothetically, facilitate the development of both the posterior and lateral kinetic chain musculature simultaneously while reducing overall time within the weight room. However, the findings of this study indicate the addition of a secondary source of resistance, band-resisted abduction in the form of an elastic fabric band, during a 5-RM BHT and/or BGB may not produce the expected results of increased GMed activity. Alternatively, significantly greater muscle activation was present only in the UGMax in the band-resisted conditions. Therefore, using an elastic fabric band for lateral chain development, in combination with the BHT or BGB, cannot be recommended when loads approach or exceed 5-RM resistance. The additional external load may exceed neuromuscular thresholds, resulting in altered muscular recruitment patterns known as synergistic dominance. Due to the presence of synergistic dominance of the UGMax over the GMed, reciprocal inhibition of the adductor muscle group and a necessitated reduction in external load for band-resisted conditions, intended outcomes may be negatively influenced. It may be best served when using sub-maximal loads, as the combination of a maximal external load coupled with an elastic fabric band does not target the muscles in a way that may be commonly thought in contemporary strength programming. Once more longitudinal studies investigating the BHT and BGB and band-resisted conditions are conducted, best practices for implementation into strength training programs may be presented.

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DISCLOSURE STATEMENT

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DATA AVAILABILITY STATEMENT

Data supporting the results and analyses presented in this paper can be found with the corresponding author.

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