Acute Effects of Thoracic-Spinal Elevation via a Novel Bench Press Pad on sEMG and Barbell Kinetics in Resistance-Trained Males

Joshua A. Kidwell*[1,2], Trent Yamamoto*[2,3], Kyle J. Hetherton*[2], Nathan Truneh*[2], Jacob J. Bright*[2], August E. Blatney*[2], Phillip Goldman*[4], Eric Neufeld[‡5,6] and Brett A. Dolezal[‡2]

[1]Creighton University School of Medicine, Omaha, NE, USA; [2]Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, USA; [3]Chobanian and Avedisian School of Medicine, Boston University, Boston, MA, USA; [4]Baylor College of Medicine, Houston, TX, USA; [5]Northwell Orthopedics. New Hyde Park, NY, USA; [6]Long Island Jewish Medical Center/North Shore University Hospital. New Hyde Park, NY, USA

*Denotes student, ‡Denotes established investigator

Abstract

International Journal of Exercise Science 19(1): 1-12, 2026. https://doi.org/10.70252/IJES2026103 This study investigated the acute effects of thoracic-spinal elevation, applied via a novel Bench Press Assist Device (BPAD), on pectoralis major activation and barbell kinetics during submaximal bench pressing. Ten resistance-trained males (23 ± 3 y) completed a randomized, single-blind, crossover trial performing five repetitions at 70 % 1-RM under standard flat bench and BPAD conditions. Bilateral surface electromyography (sEMG) assessed pectoralis major activation, while a linear position transducer recorded mean and peak barbell velocity, concentric power, and range of motion (ROM). Compared with the flat-bench condition, the BPAD produced significant increases in mean and peak velocity, bilateral pectoralis major activation (all p < 0.001), and ROM (p = 0.005). Concentric power rose by approximately 9 % but did not reach statistical significance, likely reflecting the fixed external load and the force–velocity trade-off at submaximal intensities. The observed gains in velocity and muscle activation indicate that thoracic elevation enhances mechanical efficiency and neuromuscular engagement during pressing without altering load demands. By facilitating thoracic extension and scapular retraction, the BPAD may improve length–tension relationships and joint alignment, yielding a smoother bar path and greater bilateral muscle symmetry. These findings highlight posture-focused interventions as a simple means to refine pressing mechanics, increase movement efficiency, and potentially reduce shoulder stress, likely driven by improved scapulothoracic mechanics and neural coordination. Future research should examine chronic adaptations to repeated use of thoracic elevation and its applicability across sexes, training levels, and varied load intensities.

Keywords: Bench press biomechanics, surface electromyography, thoracic elevation, neuromuscular activation, posture optimization

Introduction

The flat barbell bench press stands out as an essential exercise in any serious strength-training routine, championed by both elite athletes and fitness enthusiasts alike. Its proven ability to build

*Corresponding Author: Joshua Kidwell; Email: Jak10312@Creighton.edu

upper-body strength, promote muscular growth, and enhance upper-body muscle definition has solidified its reputation as a cornerstone exercise in modern resistance training.[1] This compound movement is a multi-joint upper-body exercise that facilitates movement in the glenohumeral, scapulothoracic, and elbow joints. Multiple prime mover and stabilizer muscle groups are engaged throughout the movement, including the pectoralis major, triceps brachii, anterior deltoids, serratus anterior, pectoralis minor, anconeus, and scapular stabilizers.[2-5] Despite the widespread use of the barbell bench press, the traditional posture of the exercise (ie. lying supine on a flat bench) may restrict scapular retraction and limit natural scapulothoracic articulation.[6–8] This restriction disrupts natural scapulothoracic movement, including protraction and upward rotation, while forcing the glenohumeral joint towards end-range motion at the bottom of the lift, which ultimately increases reliance on passive structures and reducing dynamic stability.[9] Additionally, this posture may elevated compressive and shear forces at both the glenohumeral and acromioclavicular joints, both of which are mechanical stresses associated with shoulder pathologies such as impingement, instability, and humeral hyperextension.[9,10]

Postural optimization is a widely discussed principle in resistance training intended to enhance performance while reducing injury risk. In the context of bench pressing, thoracic extension, scapular retraction, and shoulder depression are considered key for efficient force generation and maintaining joint integrity.[11] Optimizing these factors preserves shoulder mechanics, improves load distribution across the upper-limb kinetic chain, and supports efficient muscle recruitment patterns.[4,5,10] Thoracic elevation, in particular, may promote a more stable scapular position and favorable angles for the shoulder and elbow joints, improving biomechanical leverage during the lift.[6,12,13] Emerging evidence indicates that enhanced thoracic-spine extension and scapulothoracic posture may improve upper-body pressing biomechanics, potentially increasing pectoralis major recruitment and reducing anterior shoulder loading.[12,13] These positional adjustments can positively influence barbell velocity, neuromuscular output, and muscle activation patterns, all of which contribute to both performance and safety.[11] Lifters have used equipment such as bench pads, slingshots, and cambered bars to manipulate posture, range of motion (ROM), and muscle recruitment patterns ; however, empirical evidence evaluating these tools remains limited.[14] This growing interest in postural refinement has informed recent efforts to develop targeted equipment modifications that support biomechanically advantageous positioning during the bench press.

Given the biomechanical limitations associated with the traditional flat bench and posture, there has been a growing interest in developing equipment modifications that optimize muscular activation, enhance scapular mobility, and reduce joint stress and injury risk while maintaining the exercises' effectiveness for upper-body strength development. The present investigation introduces a novel bench modification, the Launch Pad™ (Advanced Muscle Mechanics, Dallas, TX, USA), specifically designed to address key biomechanical limitations of the flat bench by promoting a more natural scapular movement and improved posture alignment. This modification incorporates a contoured thoracic support intended to encourage physiological scapular retraction and posterior tilt while maintaining full pressing range of motion. Its design aligns with prior evidence showing that greater thoracic extension and scapulothoracic alignment can enhance force transmission, increase pectoralis major activation, and reduce anterior shoulder loading during horizontal pressing.[7,15] By supporting scapular retraction and improving thoracic posture, Launch Pad™ may facilitate a movement pattern that could offer performance differences compared to conventional bench press setups.[16] To objectively assess these potential biomechanical and neuromuscular benefits, advanced measurement techniques such as surface electromyography

(sEMG) and a linear position transducer (LPT) were used to evaluate muscular activation and performance-based barbell kinetics.

Accordingly, the present study examined whether the acute application of a thoracic-elevating bench pad could improve performance metrics during submaximal bench press repetitions. Enhanced thoracic extension was expected to promote more efficient scapulothoracic alignment and posterior tilt, improving pectoralis major activation and reducing anterior shoulder stress during the bench press.[10] Improved joint alignment and leverage across the shoulder and elbow may further increase force transfer efficiency,[10] while an optimized length-tension relationship and greater neuromuscular recruitment of agonist musculature can elevate sEMG amplitude and concentric force production.[4] Therefore, it was hypothesized that this intervention would lead to increased bar velocity, greater power output, and enhanced activation of the pectoralis major muscle compared to performing the exercise on a standard flat bench.

Methods

Participants

Ten healthy resistance-trained male participants (mean age: 23±3.0 years; mean training experience: 4.2 ± 1.0 weekly for at least one year) were recruited from the local college and surrounding community. Inclusion criteria required consistent, self-reported upper-body resistance training (≥ 2 sessions per week) for at least 24 months. Exclusion criteria included current musculoskeletal injury, cardiovascular or metabolic disorders, prior upper-body surgery, and use of anabolic steroids or other performance-enhancing substances within the past year. All exploratory participants were provided written informed consent while ethical approval was obtained from UCLA (IRB: 11-003190). Off-site participants provided written informed consent and single IRB approval (sIRB: BRANY, NY, USA). Research practices were conducted in accordance with the ethical principles documented in the Declaration of Helsinki and the International Journal of Exercise Science.[17] A sample size of n = 10 was calculated based on a priori power analysis using the one reptation maximum (1-RM) bench press reported from an unpublished exploratory study in our laboratory using four resistance-trained, collegiate-aged males of similar study design in our research laboratory assuming $a = 0.05$ and $B = 0.20$. This sample size of n = 10 is also supported by a study of similar design conducted by Wojdala et al.(2022), wherein activity of upper body muscles was investigated via sEMG in response to "sling shot" assisting bench press sleeves.[18]

Protocol

A randomized, single-blind, crossover study design was employed. Each participant completed an initial familiarization session and two bench press sessions under different conditions: (1) standard flat bench (CON), and (2) bench with thoracic-elevating pad (BPAD). Randomization was conducted by an independent investigator who was not involved in participant recruitment, using an online random number generator, with allocation concealment ensured through consecutively numbered envelopes and the sequence of conditions determined according to a computer-generated schedule. A familiarization session to determine participant's 1-RM and allow practice under both benching conditions was held 3-5 days prior to the first testing session. Testing sessions were separated by approximately 48 hours to minimize fatigue carryover and post-activation effects between conditions. This recovery interval was selected to ensure that each condition represented an independent, rested performance while reducing the potential

for transient potentiation or learning effects that can occur when both conditions are completed consecutively within the same session.[19,20] Although resistance-trained males can tolerate high training volumes, even minor intra-session alterations in bar path, scapular positioning, or neuromuscular potentiation can influence sEMG amplitude and barbell velocity.[21] The 48-hour separation was consistent across all participants and aligns with prior multi-day EMG reliability protocols that have demonstrated excellent reproducibility when consistent placement and normalization methods are used.[22-25] Participants were not made aware of the study's primary hypothesis and were not told which condition represented the intervention.

Equipment and setup.

A standard flat utility bench (Flat Utility Bench 2.0, Rogue Fitness, Columbus, OH, USA) was used for bench pressing, with or without the BPAD, depending on the testing condition. The bench press pad (BPAD), Launch Pad ™ (Advanced Muscle Mechanics), is made of high-density polyurethane foam with black anodized aluminum construction (30" L x 12.5" W x 3" H, weight 22 kg) and features an adjustable lumbar support that can be attached to most Olympic and competition benches as well as OEM standalone benches (Figure 1). In the experimental condition, the apex of the BPAD was aligned with the participant's thoracic spine (approximately T5–T8) to encourage scapular retraction and sternum elevation. This positioning was standardized across trials using anatomical landmarks and verified by the same investigator for all sessions.

Figure 1. Standardized setup of the BPAD on top of a traditional flat bench.

Familiarization and Warm-Up.

A familiarization session was held 3–5 days prior to testing. Standard anthropometric measurements were taken, including body mass assessed with a calibrated medical scale accurate to ±0.1 kg and height measured using a precision stadiometer (accuracy ±0.01 m). Body

fat percentage was determined using a validated octipolar, multi-frequency, multi-segmental bioelectrical impedance analyzer (BAI) (InBody Co., Seoul, Korea Republic), with participants following standard pre-measurement BIA protocols as recommended by the American Society of Exercise Physiologists.[26,27] During this session, participants underwent 1-RM testing for the barbell bench press using standard NSCA protocol and practiced both benching conditions to minimize novelty effects. During the familiarization session each repetition was performed with a standardized tempo of 2 seconds eccentric and 1 second concentric, paced via an auditory metronome, to ensure participants demonstrated proper bench press technique. This controlled tempo was used only during familiarization for safety and technical consistency; no external pacing was imposed during the experimental trials. Each testing session began with a standardized warm-up consisting of 5 minutes of low-intensity cycling, dynamic upper-body stretches, and two warm-up sets at 40% and 55% of 1-RM, separated by 2 minutes of rest.

Bench Press Protocol.

Five consecutive repetitions of the barbell bench press at 70% of each participant's 1-RM were completed using a standard 20 kg Olympic barbell and calibrated steel Olympic plates. This load was selected because 70% 1-RM has been shown to elicit high levels of muscle activation and concentric bar velocity while maintaining technical consistency and minimizing premature fatigue, making it an ideal intensity for within-session comparisons of neuromuscular performance.[28-31] Hand placement was standardized at 150% of each participant's biacromial width, measured and marked with tape on the barbell. Participants were instructed to maintain five points of contact throughout the lift: head, upper back, and glutes on the bench, and both feet on the floor. Arching beyond neutral spinal alignment was not permitted. Participants were instructed to press the barbell explosively while maintaining proper form.

Performance Metrics: Electromyography (sEMG).

Muscle activation was assessed using MR EMG wireless sEMG sensors (Dunedin, New Zealand) with a sampling frequency of 1500 Hz. These sensors include built-in analog and digital filters for noise reduction, which were used in all recordings. Electrodes were applied bilaterally to the pectoralis major using SENIAM guidelines: two-thirds of the distance between the sternum and anterior axillary line, with a 2-cm interelectrode distance. Prior to application, skin was shaved, abraded, and cleansed with 70% isopropyl alcohol. To ensure electrode placement consistency between sessions, each site was photographed and measured relative to fixed anatomical landmarks following SENIAM recommendations. The same investigator performed all placements to reduce inter-rater variability, and electrodes were reapplied at the same marked locations during the second session. This procedure has demonstrated high inter-day reliability in multi-day EMG studies.[23,24] Raw EMG data were normalized to the participant's maximum voluntary contraction (MVC) obtained during their 1-RM effort. Signal quality was verified prior to each session.

Performance Metrics: Barbell Kinetics and ROM.

A Vitruve linear position transducer (Vitruve, Madrid, Spain) was attached to the barbell sleeve to measure mean and peak bar velocity (m/s), power output (W), and range of motion (cm). Range of motion was defined as vertical barbell displacement and was calculated from the encoder's displacement-time curve. The device was calibrated before each session as per manufacturer instructions. Data was collected and synced via the Vitruve mobile application and exported for analysis.

Environmental and Temporal Controls.

All testing took place by the same investigators, in a temperature-controlled laboratory (21°C) at the same time of day (±1 hour) to control circadian influences. Footwear and attire were standardized.

Statistical Analysis

Descriptive statistics are presented as mean and standard deviation (SD). Data did not deviate significantly from normality per Shapiro-Wilk tests. Paired t-tests were utilized, and all tests were two-tailed. Effect sizes were measured by Cohen's d. Statistical significance was determined beginning with α = 0.05 before a Holm-Bonferroni correction was applied to correct the familywise error rate. All analyses were performed using R version 4.5.0 (R Foundation for Statistical Computing, Vienna, Austria).

Results

All ten male participants successfully completed the program with no missed sessions. No significant differences in age, height, body mass and body fat percentage were detected between groups before or after testing. Significant improvements were observed in mean bar velocity, peak bar velocity, and both right and left pectoralis major (PM) activation (%MVC) in the BPAD condition compared to CON (all $p < 0.001$). ROM was also greater under BPAD conditions ($p = 0.005$) compared to CON, while no significant difference in power output was observed between the two conditions (Table 1). According to Sullivan and Feinn, effect sizes corresponding to left PM %MVC, peak bar velocity, and ROM were large ($d > 0.8$), whereas those associated with right PM %MVC and mean bar velocity were moderate ($0.5 < d < 0.8$).[32] A small effect size was observed for power output ($d > 0.2$).

Table 1. Anthropometrics and Performance Measures: sEMG and Barbell Kinetics.

		Control (n=10)	BPAD (n=10)	p-between†	95% CI	d
Age (yr)	23 ± 3.0	-	-	-	-	-
Height (cm)	184.0 ± 8.5	-	-	-	-	-
Body mass (kg)	86.2 ± 17.6	-	-	-	-	-
Body fat (%)	13.2 ± 4.6	-	-	-	-	-
Right PM (%MVC)	-	70.2 ± 24.8	87.3 ± 20.1	<0.001	(11.0, 23.3)	0.76
Left PM (%MVC)	-	68.3 ± 23.4	86.8 ± 20.0	<0.001	(11.6, 25.5)	0.85
Mean Bar Velocity (m/s)	-	0.40 ± 0.09	0.47 ± 0.09	<0.001	(0.04, 0.09)	0.74
Peak Bar Velocity (m/s)	-	0.57 ± 0.11	0.66 ± 0.09	<0.001	(0.06, 0.14)	0.98
Power Output (W)	-	249 ± 103	271 ± 93	0.071	(2, 47)	0.23
ROM (cm)	-	38 ± 7	44 ± 4	0.005	(2.3, 9.3)	1.02

Values are mean ± SD. No significant differences were observed at baseline between groups. PM = Pectoralis Major, MVC = Maximum Voluntary Contraction, ROM = Range of Motion; †after correcting for multiple comparisons

Discussion

The present study examined the acute effects of thoracic-spinal elevation, applied with a novel Bench Press Assist Device (BPAD), on kinetic and neuromuscular parameters during submaximal barbell bench pressing. Significant improvements were observed under the BPAD condition in both peak and mean barbell velocity, as well as in left and right pectoralis major activation (all $p < 0.001$), and barbell range of motion ($p = 0.005$). However, no significant changes were observed in concentric power output, despite a trend indicating an approximate 9% increase.

Collectively, these results indicate that the observed changes represent immediate, posture-related enhancements in movement mechanics rather than adaptations developed through repeated training exposure, distinguishing the acute nature of this response. Such posture-induced modifications can meaningfully influence bench press mechanics and neuromuscular demand, even if not all performance metrics are equally responsive under submaximal loading.

The greater pectoralis major activation and bar velocity observed with the BPAD are likely explained by improved scapulothoracic alignment and thoracic extension, which together optimize muscle length–tension relationships and joint positioning. Enhanced thoracic elevation can increase eccentric pre-stretch of the pectoralis major, improving efficiency of concentric force generation in accordance with the stretch–shortening cycle principle.[4] Improved scapular retraction and posterior tilt may also reduce anterior shear stress at the glenohumeral joint, promoting more stable humeral translation and efficient force transfer through the upper limb kinetic chain.[7] These mechanical refinements likely enhanced neural drive and bar acceleration, which explain the velocity gains without necessarily significantly increasing total power output at a fixed submaximal load.

The significant increases in activation of both the right and left pectoralis major muscles observed with the use of the BPAD highlights its potential to enhance bilateral neuromuscular engagement during the bench press. Balanced activation of the pectoralis major is essential for maintaining symmetrical force production and joint stability, thereby reducing the risk of muscular imbalances and associated injury.[33,34] The elevated sEMG signals in both muscles suggest that the BPAD may have enhanced motor unit recruitment or firing frequency, which are key determinants of acute force output.[35] By promoting scapular retraction and thoracic extension, the device likely improved length–tension relationships and mechanical leverage across both sides of the body, supporting more coordinated, efficient muscular output (Figure 2). These adaptations, highlighted by heightened muscular activation, may have contributed to the observed increases in barbell velocity. Power output was found to increase by approximately 9%, however, the absence of significance likely reflects the fixed external load (70% 1-RM), where improvements in barbell velocity alone may be insufficient to substantially alter the overall force–velocity product.[10–12] This interpretation aligns with the established force–velocity relationship at submaximal loads: as barbell velocity and range of motion increased, the constant load likely reduced average concentric force, thereby limiting net changes in power output. Additionally, greater displacement and shifts in mechanical leverage may have redistributed force application across the lift, while variability in acceleration profiles could have further attenuated differences in mean power.

The significant increase in ROM observed in the BPAD condition suggests that thoracic elevation may allow for a deeper and more biomechanically efficient pressing pattern. By promoting thoracic extension and scapular retraction, the device likely optimized bar path and shoulder joint alignment, enabling participants to achieve greater bar displacement without compromising joint stability. We posit this extended ROM may enhance muscle fiber recruitment, particularly in the pectoralis major and anterior deltoid, by increasing the eccentric stretch phase of the lift. While improved ROM has been consistently linked to greater mechanical work and hypertrophic potential in lower-body exercises, its role in upper-body movements, especially horizontal pressing, has yielded more conflicting results.[36,37] However, the present data appear to support the significance of ROM enhancements in upper-body resistance training, suggesting that posture-focused modifications such as thoracic elevation may contribute to movement efficiency and neuromuscular activation during the bench press.
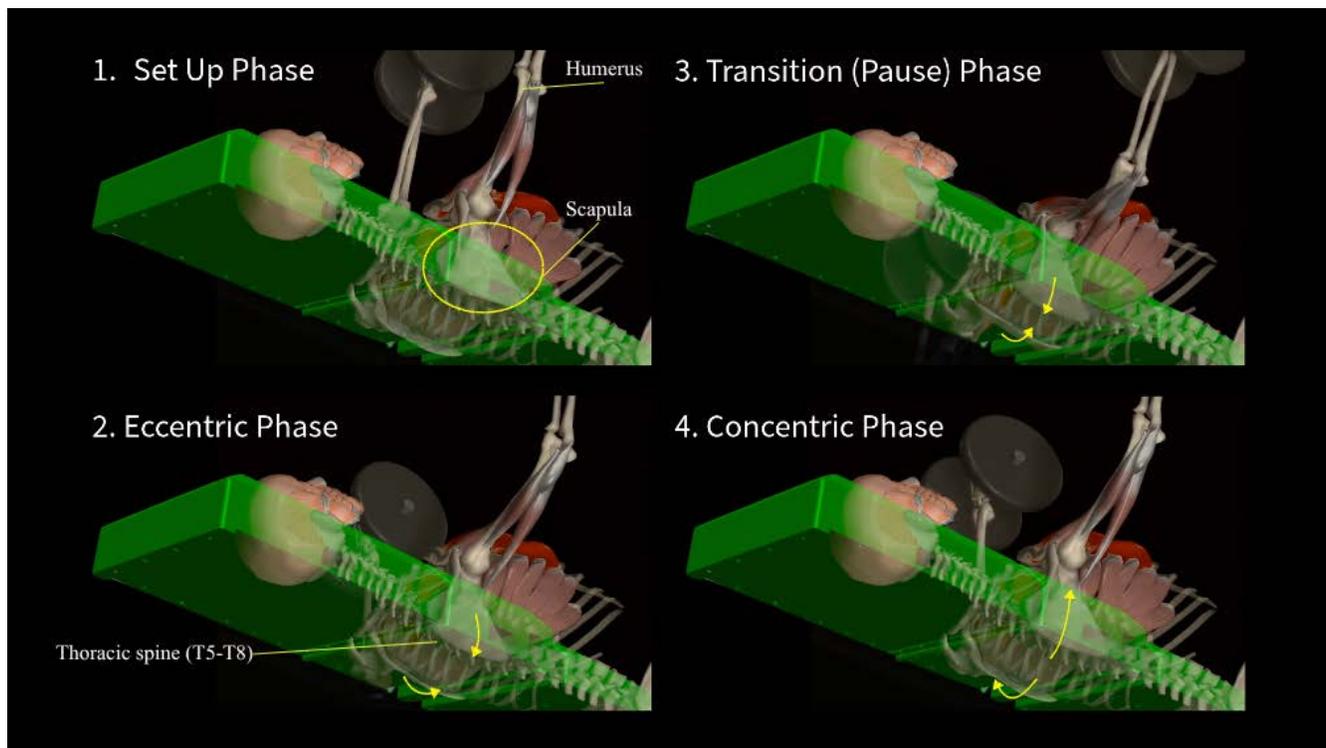
Figure 2. Scapular and thoracic positioning across bench press phases using the BPAD.

Unlike post-activation performance enhancement (PAPE) protocols, which involve a conditioning stimulus and rest period before performance testing, the current study employed a posture-based intervention that produced immediate performance benefits within a single set.[19,20] While the observed outcomes mirror the performance enhancements typically attributed to PAPE, these results are best interpreted as posture-induced improvements in movement efficiency and neuromuscular activation, rather than classical potentiation effects.

Previous research from our laboratory investigated the effects of four weeks of training with and without the BPAD in males with intermediate resistance training experience.[16] Compared to those who only trained with a traditional flat bench, the BPAD training group experienced a significantly greater increase in 1-RM bench press performance. The observed improvement was primarily attributed to the biomechanical enhancements speculated to be offered by the BPAD, but further substantiation of this link was warranted. By probing for the acute effects stemming from BPAD use on pectoralis major activation and barbell kinetics, this study provides mechanistic insight into how the BPAD improves bench press performance. Based on these findings, we posit that the BPAD's postural augmentation does indeed enhance ROM and pectoralis major activation, both of which are driving factors for improving bench press performance. These findings also align with previous research showing that modest adjustments in bar path, grip width, or torso position can meaningfully alter muscle recruitment.[1,4,14] By elevating the thoracic spine and promoting scapular retraction, the BPAD supports biomechanical strategies known to enhance shoulder kinematics and reduce injury risk, particularly related to subacromial impingement.[8] The improved joint alignment and enhanced stability may have facilitated more forceful and coordinated pressing, as evidenced by the significant increases in both mean and peak barbell velocity.

This study has several limitations. The sample size was small, though it aligns with prior sEMG-based bench press research of similar design, it limits statistical power and increases the possibility of type II error. Only one load intensity (70 % 1 RM) and a single set of five repetitions were tested, so it remains uncertain whether these effects persist at different intensities or with repeated sets. Anthropometric factors such as limb length and thoracic curvature, which may influence interaction with the pad, were not controlled. Additionally, although sEMG provides reliable assessment of surface muscle activity, it cannot evaluate deeper stabilizers or synergistic musculature. Another potential factor that may have influenced the inter-day variability of these results is that familiarization and the two testing sessions were conducted on separate days, which may have been affected by slight variations in electrode placement, hydration levels, or daily recovery status.

The study sample consisted exclusively of resistance-trained males, which limits the generalizability of these findings to females or novice lifters. Women demonstrate greater glenohumeral laxity, smaller subacromial space width, and altered scapular motion patterns compared with men, including increased upward rotation and anterior tilt during arm elevation.[38–40] These biomechanical distinctions, together with a higher prevalence of multidirectional instability in female athletes,[38] may influence how thoracic elevation affects shoulder mechanics and muscle activation during pressing movements. Untrained or sedentary individuals may exhibit smaller or delayed responses due to lower neuromuscular efficiency. Future research should determine whether comparable effects occur across sexes, training levels, and age groups.

Further research should involve more diverse populations and examine the long-term effects of training with thoracic elevation. It should be determined whether this improvement can be augmented with a longer training period and if a similar improvement would be observed in untrained, sedentary individuals. Randomized controlled trials evaluating strength, hypertrophy, and injury outcomes over several weeks would provide insight into the practical significance of these findings. Comparative studies evaluating posture-modifying tools (e.g., slingshots, wedges, cambered bars) could help isolate the mechanisms responsible for observed performance changes. Incorporating force platforms and motion capture would allow for a more detailed analysis of joint angles, load distribution, and force-time dynamics. Additionally, although our normalization protocol followed established inter-day reliability procedures, future studies could consider same-day crossover designs to further eliminate residual variability.

In conclusion, this study demonstrates that thoracic-spinal elevation via the Bench Press Assist Device (BPAD) can acutely enhance key performance metrics during the barbell bench press, including barbell velocity, range of motion, and bilateral pectoralis major activation. These improvements suggest that subtle, posture-focused interventions can meaningfully influence neuromuscular engagement and lifting mechanics, even without altering load. While power output did not significantly change under the tested conditions, the observed benefits in velocity and muscle activation point to enhanced mechanical efficiency. These findings contribute to the growing body of evidence supporting the biomechanical and functional relevance of thoracic alignment and scapular positioning in resistance training. In application, emphasizing thoracic extension or incorporating thoracic-elevating supports may help athletes and coaches enhance pressing performance, refine technique, and reduce shoulder strain during training. Future research should explore the long-term adaptations to training with thoracic elevation, as well as its applicability across diverse populations and training intensities.

Acknowledgements

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