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Effects of combining weight training and calisthenic exercises on strength and body circumference measurements in U-23 national wrestlers

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Abstract

Background and Study Aim: Wrestling requires high levels of physical strength, endurance, and specialized training adaptations to support performance at the elite level. Combining different training modalities may enhance these adaptations more effectively than using them in isolation. The objective of this study is to examine the effect of incorporating calisthenic exercises into sport-specific resistance training programs on specific physiological and performance parameters in elite-level wrestlers.

Material and Methods: The study included 22 male wrestlers aged 18–20, all competing at the national team level. Participants were randomly divided into two groups based on their competitive weight categories, with 11 wrestlers in each group. All participants continued their regular wrestling training three times per week for eight weeks. The first group performed weight training using a pyramidal method. The loads varied between 80–100% of their maximum strength. The second group followed the same weight training program but additionally performed calisthenic exercises designed to enhance wrestling-specific strength.

Results: At the end of the eight-week training period, the first group, which performed only weight training, showed significant increases in biceps circumference measurements and handgrip strength ($p<0.05$). Conversely, the second group, which incorporated calisthenic exercises into their weight training regimen, exhibited significant improvements in chest and biceps circumference. They also showed increased handgrip strength (both right and left), as well as back and leg strength parameters ($p<0.05$).

Conclusions: The integration of calisthenic exercises into weight training programs has been identified as a highly effective strategy for enhancing wrestling-specific strength development. This approach has been demonstrated to provide substantial benefits in meeting the unique strength requirements of wrestlers.

Keywords: strength, calisthenic exercises, resistance training, elite wrestlers, muscle adaptation, training program

Introduction

Wrestling is a sport that demands that athletes possess exceptional levels of physical strength, endurance, flexibility, speed, and technical proficiency. Achieving success in this discipline depends not only on athletes' physical capabilities. It also requires the efficient use of energy systems and tactical decision-making [1]. Both the aerobic and anaerobic energy systems are heavily engaged during wrestling competitions. This highlights that energy production and endurance are critical components of performance. Strength is also a key factor in wrestling success. It is an essential part of training. Enhancing strength improves athletes' physical dominance during competition and plays a crucial role in minimizing the risk of injury [2].

Endurance training plays a pivotal role in regulating arterial oxygen saturation (SpO_2). This directly influences aerobic capacity and recovery performance in high-intensity sports. Existing research indicates that aerobic exercise improves hemoglobin oxygen saturation in arterial blood. This, in turn, contributes to enhanced athletic performance. Moreover, the incorporation of effective recovery protocols following high-intensity exercise has been recognized as essential for sustaining subsequent performance levels [3,4]. In high-intensity sports such as wrestling, where both anaerobic and aerobic energy systems are heavily activated, oxygen saturation is likely to be a key factor. It affects not only endurance capacity but also rapid recovery and the maintenance of high-intensity performance throughout the competition. The existing body of literature includes numerous studies examining the impact of various strength

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training protocols on muscle strength, endurance, and overall athletic performance. Bompa and Haff underscored the pivotal role of strength training in optimizing athletic outcomes across different sports disciplines [5]. Resistance training has been shown to produce substantial benefits in muscle hypertrophy, neuromuscular adaptations, and metabolic capacity. These factors are particularly critical for wrestlers [6].

Calisthenic exercises refer to bodyweight-based movements designed to enhance overall strength, as well as balance, flexibility, and endurance. These exercises have been extensively studied in the sports science literature. In particular, they have shown a positive impact on muscular endurance, coordination, and agility [7]. Other research highlights that calisthenic training significantly contributes to improving body composition and physical fitness levels. Additionally, it is recognized as a practical and efficient method for increasing muscular endurance and strength [8,9].

Analysis of previous research findings shows that resistance and calisthenic training, when applied separately, offer well-established benefits for strength development and physical conditioning. The authors emphasize that, despite this knowledge, there is a notable lack of studies examining the combined use of these two modalities in elite-level wrestlers. While existing literature has explored their individual effects, research addressing their simultaneous application in sport-specific contexts remains scarce. Therefore, there is a continuing need for systematic and methodologically sound investigations focused on the physiological and performance outcomes of such combined training programs in highly trained athletes.

In this context, the present study aims to examine the effects of incorporating calisthenic exercises into sport-specific resistance training programs on selected physiological and performance parameters of elite wrestlers.

Materials and Methods

Participants

This study was conducted with 22 elite student wrestlers competing at the national level. To ensure a balanced distribution across competitive weight categories, the participants were randomly assigned to two groups. Participation was voluntary. The study was approved by the Bartin University Ethics Committee (Decision No. E-23688910-050.01.04-2300000252).

Research Desing

This study was conducted within the framework of a pretest-posttest control group experimental design. Participants were stratified into blocks based on their competitive weight categories to ensure balanced allocation. Within each block, randomization was performed using a computer-generated random number table created in Microsoft Excel. This table randomly assigned each participant to either the weight training group or the weight + calisthenic training group.

The first group underwent their regular wrestling training combined with strength-oriented weight training (n = 11; mean age: 19.18 ± 3.68 years; mean training experience: 8.81 ± 3.15 years; mean height: 171.90 ± 7.23 cm). The second group followed an identical training program but incorporated additional calisthenic exercises three times per week (n = 11; mean age: 20.00 ± 2.28 years; mean training experience: 9.54 ± 3.01 years; mean height: 175.00 ± 8.83 cm) (Table 1).

In this study, due to the nature of the intervention and assessment processes, both the trainers and the evaluators were aware of group assignments. Therefore, blinding was not implemented. However, to minimize the risk of assessment bias, all measurements were carried out based on standardized protocols and objective assessment tools. Throughout the 8-week study period, participants' regional strength, body circumference measurements, and oxygen saturation levels were evaluated through pre- and post-test assessments.

Measurements

This study evaluated changes in handgrip strength, back strength, leg strength, and oxygen saturation levels. Strength measurements were conducted using digital dynamometers (Takei brand) to assess handgrip and back-leg strength. Oxygen saturation levels were measured using a pulse oximeter. Body circumference measurements were taken with a measuring tape accurate to 0.1 mm. All measurements were performed twice: at the beginning of the study and again at the end of the 8-week intervention period. The effects of combining weight training with calisthenic exercises on wrestling-specific strength development and physiological adaptations were analyzed.

Weight Training Program

Athletes in this group participated in 10 training sessions per week. These included three double-session days and two single-session days. Each session lasted approximately 120 minutes, with four sessions specifically allocated to weight training. The weight training program followed a pyramidal approach, utilizing loads between 80% and 100% of the participants' one-repetition maximum (1RM). The exercises focused on major muscle groups, including the back, legs, chest, and arms. Each exercise was performed in three sets. The number of repetitions was adjusted according to the relative load intensity.

Weight + Calisthenic Training Program

In addition to the program followed by the

group performing weight training, athletes in this group completed calisthenic exercises aimed at developing wrestling-specific strength. These exercises were performed after four wrestling sessions per week. The training regimen included a variety of exercises, such as rope climbing, push-ups, sit-ups, partner-resistance drills, and carrying drills. The exercises were specifically designed to reinforce movement patterns and strength demands unique to wrestling. Each exercise was performed in three sets. Adjustments were made according to the athletes' individual capacities.

Statistical Analysis

The data analysis was performed using version 26.0 of the statistical software package SPSS. Skewness and kurtosis values were examined to assess the normality of the data distribution. Values within the acceptable range of ±2 indicated a normal distribution [10]. In addition, a priori power analysis was conducted using G*Power software to justify the adequacy of the sample size. Based on a medium effect size (d = 0.5), an alpha level of 0.05, and a statistical power of 0.80, the sample size was determined to be sufficient for detecting significant effects. Given that the assumptions of normality were met and the measurements were continuous and paired, a paired-samples t-test was employed to compare pre-test and post-test scores within each group.

All variables followed a normal distribution (skewness and kurtosis values within ±2). The data were continuous and measured within subjects over time. Therefore, a paired-samples t-test was selected as the appropriate method for comparing pre- and post-test values. Although the sample size was relatively small (n = 11 per group), parametric assumptions were considered satisfied. This conclusion was based on normality diagnostics and the robustness of the t-test under these conditions.

In addition to p-values, effect sizes (Cohen's d) and 95% confidence intervals were calculated. These were used to assess the magnitude and precision of the observed differences. These values are reported alongside statistical significance levels for all main outcomes.

Given the number of comparisons (n = 24), a Bonferroni correction was applied to adjust for multiple testing. The adjusted significance threshold was set at $p < 0.0021$. Only a limited number of outcomes remained statistically significant after correction.

Results

The demographic characteristics of the wrestlers are presented in Table 1, categorized into the Weight Training Group and the Weight + Calisthenic Training Group. The demographic characteristics indicate that the two groups were comparable in terms of age, training experience, and height. Minor variations were observed, but they do not appear substantial enough to have influenced the outcomes of the intervention.

The within-group comparison of pre- and post-test results for the Weight Training Group is presented in Table 2.

As shown in Table 2, statistically significant increases were observed in biceps circumference and left-hand grip strength following the 8-week weight training program ($p < 0.05$). In contrast, no significant changes were found in body weight, shoulder, chest, waist, hip, and thigh circumferences, nor in right-hand grip strength, back strength, leg strength, or oxygen saturation levels ($p > 0.05$). These findings suggest that the training protocol was particularly effective in enhancing upper extremity muscular strength on the non-dominant side and specific regional muscle development, while it did not lead to significant changes in overall body composition or other physiological parameters.

The results for the group that performed both weight training and calisthenic exercises are presented in Table 3. Pre- and post-test comparisons reveal the specific variables in which statistically significant changes occurred after the 8-week intervention.

As shown in Table 3, statistically significant increases were observed in chest and biceps circumferences, both right and left handgrip strength, back strength, and leg strength following the 8-week combined training program ($p < 0.05$). In contrast, no significant changes were found in body weight, shoulder, waist, hip, and thigh circumferences, or in oxygen saturation levels ($p > 0.05$). These results indicate that adding calisthenic exercises to a traditional weight training regimen may enhance upper and lower body strength more effectively, while having limited effects on certain anthropometric and physiological variables.

Table 1. Demographic Characteristics of the Participants

Group	n	Age Mean ± SD	Training Age Mean ± SD	Height Mean ± SD.
Weight Training Group	11	19.18±3.68	8.81±3.15	171.90±7.23
Weight + Calisthenic Training Group	11	20.00±2.28	9.54±3.01	175.00±8.83

Table 2. Test Results of the Weight Training Group

Variable	Pre-Test	Post-Test	t	p
	Mean ± SD	Mean ± SD		
Body Weight (kg)	70.56 ± 7.31	70.82 ± 8.57	-0.398	.699
Shoulder Circ. (cm)	114.54 ± 4.15	114.63 ± 4.36	-0.289	.779
Chest Circ. (cm)	95.00 ± 3.79	95.90 ± 4.74	-1.992	.074
Biceps Circ. (cm)	33.45 ± 3.07	34.45 ± 3.23	-7.416	.000*
Waist Circ. (cm)	79.81 ± 5.09	79.90 ± 5.20	-0.430	.676
Hip Circumference (cm)	96.72 ± 4.26	97.00 ± 5.34	-0.504	.625
Thigh Circ. (cm)	55.36 ± 4.31	55.36 ± 4.17	0.000	1.000
Handgrip Strength-right (kg)	44.88 ± 6.33	47.00 ± 7.49	-1.318	.217
Handgrip Strength-left (kg)	42.84 ± 7.01	45.44 ± 6.30	-2.520	.030*
Back Strength (kg)	137.29 ± 25.51	139.63 ± 24.40	-1.118	.290
Leg Strength (kg)	132.10 ± 23.76	136.54 ± 30.82	-1.103	.296
Oxygen Saturation (%)	99.94 ± 0.68	99.09 ± 0.70	1.838	.096

* $p < .05$; Circ. = circumference measurements.

Table 3. Test Results of the Weight + Calisthenic Exercise Group

Variable	Pre-Test	Post-Test	t	p
	Mean ± SD	Mean ± SD		
Body Weight (kg)	80.43 ± 14.31	80.38 ± 14.68	0.088	.931
Shoulder Circ. (cm)	122.63 ± 8.24	122.54 ± 8.39	0.430	.676
Chest Circ. (cm)	101.09 ± 7.76	103.45 ± 8.11	-9.690	.000
Biceps Circ. (cm)	37.27 ± 4.26	38.90 ± 4.52	-8.050	.000
Waist Circ. (cm)	81.81 ± 8.47	81.81 ± 9.03	0.000	1.000
Hip Circ. (cm)	101.00 ± 7.00	102.90 ± 7.11	-9.037	.000
Thigh Circ. (cm)	56.72 ± 5.83	56.63 ± 6.16	0.559	.588
Handgrip Strength-right (kg)	52.68 ± 5.24	57.62 ± 7.26	-3.809	.003
Handgrip Strength-left (kg)	49.90 ± 5.29	58.62 ± 6.66	-5.938	.000
Back Strength (kg)	157.00 ± 30.50	168.81 ± 27.87	-3.718	.004
Leg Strength (kg)	152.55 ± 18.77	162.54 ± 20.00	-2.316	.043
Oxygen Saturation (%)	98.72 ± 1.10	98.63 ± 0.92	0.247	.810

$p < 0.05$; Circ. refers to circumference measurements.

Discussion

This study aimed to evaluate the effects of combining weight training with calisthenic exercises in competitive wrestlers. In the weight training group, significant increases were found only in biceps circumference and handgrip strength (Table 2). This suggests localized muscular adaptations. In contrast, athletes who additionally performed calisthenic exercises demonstrated broader improvements. These included back and leg strength, as well as upper body parameters (Table 3).

Previous studies have demonstrated that calisthenic exercises contribute to improvements in both body composition and muscular strength [11]. The current findings support and expand upon this evidence. They show that the integration of calisthenics into resistance training enhances not only localized hypertrophy but also leads to more comprehensive muscular adaptations in elite athletes. This aligns with findings reported in [6], which highlighted the muscle group–specific effects of resistance training. It also complements results from other studies that demonstrated improvements in muscular strength following eight weeks of calisthenic training [12]. Furthermore, research has indicated that calisthenics alone may have limited effects on lower-limb strength. However, their combination with resistance training yields more pronounced benefits [13, 14, 15, 16]. These results were confirmed in the present study. Enhanced performance was observed across multiple strength indicators in the combined training group. Such improvements were not seen in the weight training group alone.

Overall, these findings suggest that calisthenic exercises may stimulate additional neuromuscular pathways or functional movement patterns. These are not fully activated by traditional resistance training. Thus, the present study contributes to the literature. It provides evidence that a hybrid training model is more effective in eliciting comprehensive strength gains among already well-trained individuals.

The results suggest that wrestlers who incorporated calisthenic exercises into their weight training programs demonstrated significant improvements in chest, biceps, and hip circumference, as well as notable increases in back and leg strength (Table 3). These findings suggest that calisthenic exercises may lead to more dynamic and functional strength gains compared to traditional weight training. The literature supports that calisthenic exercises simultaneously engage large muscle groups and improve motor skills such as balance, flexibility, and coordination [7,14]. Previous studies have indicated that full-body calisthenic training can be effective in enhancing muscular endurance, strength, force steadiness, and dynamic balance [15,16]. In this context, it can be suggested that calisthenic exercises may contribute to improved athletic performance by promoting strength gains in major muscle groups.

In contrast, in the weight training group, variables such as thigh circumference, back and leg strength, and oxygen saturation did not show significant improvements. These findings likely reflect the specificity of the training intervention, which emphasized upper-body muscle groups using high-load resistance exercises. Consequently, lower-limb musculature and cardiorespiratory responses may not have been sufficiently stimulated to elicit measurable changes. Moreover, oxygen saturation typically remains stable in trained athletes unless the exercise regimen includes aerobic, high-volume, or hypoxic components. The lack of change in these parameters underlines the need for more targeted or varied training protocols when aiming to induce adaptations beyond localized strength gains.

The literature reports varying findings regarding the effects of calisthenic exercises on both body composition and muscular strength. Some studies have indicated that these exercises improve body composition by increasing fat-free mass (FFM) and reducing regional body fat percentage (BFP) [17, 18]. In a study conducted by [19], it was reported that calisthenic training programs applied over an 8-week period led to positive improvements in overall body composition. Additionally, calisthenic exercises have been noted to enhance muscle strength [20]. Strength and endurance, which are fundamental components of muscle fitness, are positively influenced by calisthenic exercises [21, 22]. These exercises are particularly reported to support motor skills such as balance, coordination, and flexibility. They thereby improve physical fitness components in athletes [23, 24, 25]. In one study, progressive calisthenic push-up training was shown to be as effective as free-weight bench press exercises in increasing upper body muscle strength and thickness [26]. Other studies have also demonstrated that morphological adaptations related to body shaping are evident in athletes engaged in calisthenics-based training [27, 28]. The findings of the present study align with previous literature and suggest that calisthenic exercises may contribute not only to strength development but also to morphological adaptations related to body shaping.

When examining oxygen saturation levels, no significant changes were observed in either group. However, a slight, non-significant decrease was recorded in the calisthenic exercise group. This finding appears to align with the literature suggesting that high-intensity exercises may temporarily reduce oxygen saturation levels but promote long-term cardiovascular adaptation. It has been reported that high-intensity exercise can cause temporary reductions in arterial oxygen saturation, a phenomenon referred to as exercise-induced arterial hypoxemia (EIAH) [3]. Regular high-intensity exercise may lead to short-term reductions in oxygen saturation. However, it can also promote respiratory and cardiovascular adaptations in the long term, thereby enhancing oxygen transport and recovery capacity [4, 29, 30]. The findings are consistent with previous literature. They indicate that although high-intensity training may lead to temporary reductions in oxygen saturation, it may contribute to long-term improvements in cardiovascular endurance through physiological adaptation.

Limitations and Future Research Directions

This study has certain limitations. The sample size was relatively small, and participants were limited to elite student wrestlers. These factors may affect the generalizability of the findings to broader athletic populations or individuals with different training backgrounds. Additionally, the intervention period was limited to eight weeks, which may not be sufficient to observe long-term adaptations or physiological changes. However, given that not all physiological or anthropometric variables showed significant changes, further well-controlled studies are required to evaluate the long-term effects of such interventions, particularly on oxygen saturation and overall endurance.

The present study provides important findings regarding the integration of calisthenic exercises into traditional resistance training programs. In this context, it may be suggested that calisthenic exercises can be incorporated into routine training regimens

during the pre-competition period to enhance both regional and functional strength development in wrestlers. Furthermore, the demonstrated synergistic effects on multiple strength indicators imply that combining these modalities may optimize performance adaptations more effectively than resistance training alone. Coaches and practitioners should consider implementing hybrid training models and monitoring athlete responses to tailor programs for maximal benefit.

Conclusions

In light of the findings, it may be suggested that incorporating calisthenic exercises into traditional weight training programs is associated with greater improvements in upper and lower body strength parameters compared to weight training alone. These results indicate potential benefits of combined training for enhancing wrestling-specific strength. These findings may inform training program design for combat sports where both upper and lower body strength are critical.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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