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Original Article

The impact of elastic and battle rope training on physiological and physical indicators in individual sports athletes

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Abstract
Objectives: The primary aim of this study was to assess the impact of Elastic and Battle Rope Training physiological and physical indicators among athletes participating in individual sports. **Methods:** An experimental design was employed, involving 40 participants from Al-Adalah in Saudi Arabia. Participants were divided into two groups: the experimental group (n = 20; age: 17.20 ± 0.72 years; height: 169.60 ± 1.67 cm; weight: 68.60 ± 1.99 kg; training experience: 5.30 ± 0.47 years) and the control group (n = 20; age: 17.30 ± 0.73 years; height: 169.80 ± 1.70 cm; weight: 68.65 ± 2.08 kg; training experience: 5.40 ± 0.50 years). Physical performance was evaluated using the Sit-Up Test, Plank Test, and Medicine Ball Test, while physiological assessments included measurements of heart rate (HR) and blood pressure, conducted with a Beurer blood pressure monitor (model Bc28 | 57144). The training program was administered over 8 weeks, comprising three sessions each week. **Results:** The findings revealed significant improvements in heart rate and systolic blood pressure (SBP), with p-values indicating statistical significance ($p < 0.05$; $p = 0.001$) favoring the experimental group at post-intervention assessments. Furthermore, substantial enhancements were observed in physical performance metrics, as indicated by the Sit-Up Test, Plank Test, and Medicine Ball Test, also achieving statistical significance ($p = 0.001$). The experimental group outperformed the control group, with improvement rates ranging from 3.03% to 27.33% ($p = 0.001$). **Conclusions:** The results affirm that Elastic and Battle Rope Training constitutes an effective training approach for athletes engaged in individual sports. Future research should investigate the influence of such training on biochemical parameters like lactic acid and hemoglobin levels, as these metrics are pivotal in comprehending the body's response to rigorous training and subsequent recovery capability. Additionally, further studies should explore the impact of these training modalities on the psychological traits of athletes, such as motivation, psychological endurance, and coping mechanisms under stress, which are crucial determinants of athletic performance.
Keywords: Battle Ropes, 4D PRO; -Heart rate; Systolic blood pressure; Plank; Athletes

Introduction

Resistance training techniques have changed greatly in modern society, and there are various types of training without conventional weights: bodyweight exercises and resistance bands for muscle strength and training in general. Studies show that one can make massive enhancements in muscle power with one finding recording 49.9% enhanced after 8 weeks (Kadhim IF. et al. 2024, Fyfe j j. et al., 2021). The American Heart Association also points out the benefit of bodyweight exercises and resistance bands especially if one has little equipment the organization also points out that even shorter workouts of 15 to 20 minutes give considerable health gains (Bardstu H.B.et al., 2020). Also, cardiovascular fitness, blood pressure, and overall bone density have been associated with resistance training benefits for persons with musculoskeletal disorders (Ramos-Campo DJ.et al., 2021). Resistance tools like resistance ropes (4D Pro, Battle Rope) have a critical role of supplementing motor performance and physical strength in athletes. These equipment’s make use of ones body mass and force in order to enhance ones power, velocity and other aspects of athletic ability. Resistance training that involves ropes has walked tall in the promotion of the athletic motor skill competencies (AMSC) in children; thus boosting their physical performance (Pullen BJ. et al., 2020). In a study concerning adolescent male athletes, the authors provided evidence that both vertical and horizontal resistance training enhanced motor skill performance when combined, with stress on proper movement strength as a base for creating power and speed (Pichardo AW. et al., 2019). Battle rope exercises have acute impact on performance related parameters for instance shooting accuracy and pass speed thus can be effective during training session meant to improve technical ability under fatigue (Chen WH. et al. 2020).However as much as resistance tools help in improving motor performance it is important to look at the timing of their utilization in training, as their usage may have acute negative impact especially before competition fixtures (Chen et al., 2020).

Strength training is considered effective and superior in building lean body mass (Wewege et al., 2021). A study published by Bachero-Mena B,(2021) and colleagues noted that high speed resistance training lead to

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improved performance measures in athletes such as speed and power during sprinting and jumping movements due to increased neuromuscular co-activation. RT using circuit based training has also shown enhancements in cardio respiratory endurance with increase in VO2 max by 6.3 % (Ramos-Campo et al., 2021). This concludes that resistance training can indeed provide support to aerobic training in order to enhance general endurance. Despite this, resistance training is very effective and an important aspect to note is that depending on the training status of the individuals and the program design, which may include had to make some modification when, stiffness adaptations may be required because the research was conducted in a low resource setting (Shaw & Shaw, 2020). Elastic and battle rope training can bring about a marked upgrade in such parameters relating to strength, power and endurance in an athletic calendar. These training modalities have features that, if implemented, may result in enhanced athletic performance. A study of collegiate basketball players noted that battle rope exercises raised blood lactate concentration and perceived effort as a way of exhibiting a high intensity workout. However, it reduced the performance in shooting accuracy and pass speed, meaning it is rather suitable for conditioning than for pre-competition performance (Chen et al., 2020) An 8-week elastic band based plyometric training parameters improved sprint velocities and showed significant change in the areas of dynamic stability with the respective control groups elasticity in the case of junior handball players (Aloui et al., 2020). Negra et al. (2019) found that soccer young players of both genders improved their change in direction speed, their sprint, and their horizontal and vertical jumps by 8 weeks of a twice per week of plyometric program with a weight vest and Kobal et al. (2017) found that young male soccer players had improvement in their sprinting and vertical jumping in six weeks of bi-weekly of plyometric training with handheld dump

The extant body of literature (Kadhim IF et al., 2024; Fyfe JJ et al., 2022; Bornath DPD, Kenno KA. (2022); Arias JÁ, 2021; Aloui G et al., 2020; Bårdstu HB et al., 2020; Pullen BJ et al., 2020; Chen WH, 2020; Aloui G et al., 2019; Pichardo AW et al., 2019; Sung, K.D. et al. 2019) underscores the significance of resistance training utilizing resistance ropes. It has become evident that the performance of athletes in individual sports is suboptimal, and there appears to be a lack of focus from coaches regarding this issue. In light of this, researchers have begun to explore contemporary tools and methodologies aimed at enhancing physical performance and physiological well-being in athletes. This has motivated the present study, which utilizes Elastic and Battle Rope Training exercises to evaluate their effects on various physiological and physical indicators among athletes participating in individual sports. Notably, prior assessments of the athletes' physiological and physical variables were absent, thereby justifying the necessity of this investigation. Consequently, we hypothesize that the implementation of these training modalities will yield significant differences in pre- and post-intervention measurements within both the experimental and control groups concerning the physiological and physical indicators of the athletes. where the experimental group exhibits superior measurements compared to the control group.

Materials and Methods

Participation and Study design:

The purpose of this study was to determine the effects of Elastic and Battle Rope Training on physiological and physical responses of individual sport athletes. The participants of the study were 40 athletes who trained in Al-Adalah Club in Al-Ahsa, Saudi Arabia. Anthropometric measurements were taken from two groups of participants; actual Elastic and Battle Rope Training was performed by 20 participants (mean ± standard deviation, age = 21.24 ± 0.14 years) while 20 participants (mean ± standard deviation, age = 21.24 ± 0.14 years) just did not participate in this type of training. The research was conducted in a way that did not include athletes with preexisting conditions so as to independently compare the results. Each of the study participants was clearly informed concerning the risks that are inherent with participation in the study and were 'informed consent' whereby the participants filled consent forms in compliance with the ethical principles of the Declaration of Helsinki. The training regimen employed in this research was specifically developed for the study. To standardize testing conditions, participants were instructed to refrain from the consumption of alcohol and caffeine, as well as to avoid engaging in strenuous physical activities for a period of 48 hours prior to both testing and training sessions. Additionally, to control for performance variations attributable to circadian rhythms, all training sessions were conducted at the same time of day. The Elastic and Battle Rope Training program was administered over a duration of eight weeks, consisting of a total of 24 training sessions, with sessions scheduled on alternate days: Sundays, Tuesdays, and Thursdays. The research was conducted from March 2024 to May 2024, with pre-study measurements occurring from March 3 to March 5, 2024. The implementation of the Elastic and Battle Rope Training program took place from March 10 to May 3, 2024 (refer to Appendix A), followed by the collection of post-study measurements from May 4 to May 6, 2024.

Table 1. Descriptive statistics:

variables	Experimental				Control			
	Mean	SD	Min	Max	Mean	SD	Min	Max
age	17.25	0.72	16.00	18.00	17.30	0.73	16.00	18.00
height	169.60	1.67	166.00	172.00	169.80	1.70	166.00	172.00
WIGHT	68.50	1.99	65.00	72.00	68.65	2.08	65.00	72.00
Training	5.30	0.47	5.00	6.00	5.40	0.50	5.00	6.00

Min = Minimum; Max = Maximum; SD= standard Deviation

Tools, Devices and Testing Procedures:

A restameter was utilized to accurately measure the height and weight of participants, who were instructed to wear no shoes or tops while donning shorts that accounted for a predetermined weight, thereby facilitating the recording of their naked weight. Measurements were taken approximately 12 hours postprandially. In the assessment, participants were positioned centrally on the weighing scale, maintaining a forward gaze throughout the process. Height was recorded in centimeters, while body weight was measured in kilograms (Hassan et al., 2023). Heart rate (HR) and blood pressure were measured using a Beurer blood pressure monitor (model BC28 | 57144). The reliability of this device was established through comparisons with other monitoring instruments. Participants were advised to arrive for testing either in the morning or 3 hours following their last meal. Before the commencement of testing, participants were thoroughly briefed on the study's objectives and the testing protocols that would be implemented. The physical variables were assessed using standardized tests, including the Sit-Up, Plank, and Medicine Ball Test (refer to Appendix B). An exploratory study design was employed, wherein measurements were applied to an external sample to further ensure the validity and reliability of the assessments. All research variables were predetermined prior to initiating the training program, and participants were required to abstain from engaging in any strenuous physical activities for 48 hours preceding the evaluation session. Prior to data collection, a 15-minute warm-up session was implemented, which consisted of steps and short-distance running. Physical assessments were conducted in an unbiased manner, where evaluation tests were administered uniformly to all participants.

Training Program Protocol:

Training Program Protocol: The training regimen was methodically executed eight weeks, focusing on the effects of Elastic and Battle Rope Training on physiological and physical indicators in athletes participating in individual sports. The experimental group engaged in training sessions that incorporated both Elastic and Battle Rope Training, scheduled three times per week. Each training session lasted between 70 and 90 minutes, with intervals of 60 to 90 seconds allocated between exercises. The intensity of the training was maintained at 70-85% of the participants' maximum heart rate. The training sessions were segmented into distinct phases. The initial preparation phase lasted 15 minutes and consisted of activities such as walking, running, jogging to adequately warm up the participants. This was followed by the main phase, which spanned 30 to 60 minutes and focused on specific physical exercises utilizing Elastic and Battle Ropes. During this main phase, heart rates of all participants were meticulously recorded to monitor physiological responses to the training regimen. The training concluded with a recovery section lasting 5 minutes, which included stretching exercises and relaxation techniques to promote physical recovery and flexibility (as detailed in Appendix A and further illustrated in Table 2). This structured approach to training with Elastic and Battle Ropes not only aimed to enhance physical performance but also ensured the safety and well-being of the athletes throughout the training program.

Table 2. Time distribution of the program

Week	Day	Elastic and Battle Rope Training	*Group*	*Rest*		*Int %*
				B ex	***B G***	
First	*1*	*7,8,30,27,30,44*	*3*	*60 s*	*40 s*	*70%*
	2	*13,16,17,30,40*	*4*	*60 s*	*65 s*	*70%*
	3	*3,30,14,25,40,48*	*5*	*60 s*	*60 s*	*70%*
Second	*4*	*15,18,19,25,46*	*4*	*75 s*	*40 s*	*75%*
	5	*12,14,32,20,39,45*	*5*	*60 s*	*45 s*	*75%*
	6	*33,36,25,37, 41*	*4*	*60 s*	*45 s*	*75%*
Third	*7*	*4,5,29,33,41,47*	*5*	*65 s*	*40 s*	*85%*
	8	*33,37,21,30,43*	*4*	*75 s*	*45 s*	*75%*
	9	*2,28,11,27,42,54*	*3*	*75 s*	*55 s*	*70%*
Fourth	*10*	*13,20,21,26,39,55*	*4*	*65 s*	*45 s*	*75%*
	11	*10,19,25,32,9,52*	*5*	*60 s*	*45 s*	*80%*
	12	*21,22,23,29,38,49*	*5*	*65 s*	*45 s*	*70%*
Fifth	*13*	*29,20,22,34,43*	*5*	*80 s*	*50 s*	*80%*
	14	*17,18,31,23,40*	*4*	*60 s*	*50 s*	*70%*
	15	*1,22,16,25,38,48*	*4*	*70 s*	*45 s*	*75%*
Sixth	*16*	*16,26,12,33,43*	*5*	*80 s*	*45 s*	*75%*
	17	*19,20,24,37,38*	*4*	*85 s*	*55 s*	*70%*
	18	*11,13,17,22,37*	*3*	*60 s*	*60 s*	*75%*
Seventh	*19*	*2,18,17,24,40,69*	*4*	*65 s*	*40 s*	*75%*
	20	*23,24,25,36,40,46*	*4*	*60 s*	*40 s*	*80%*
	21	*3,9,12,33,38,37*	*5*	*65 s*	*75 s*	*85%*
Eighth	*22*	*1,22,32, 29, 2,51*	*3*	*60 s*	*50 s*	*80%*
	23	*20,23,28,22,43,50*	*4*	*90 s*	*60 s*	*85%*
	24	*23,34,28,31,52*	*4*	*65 s*	*75 s*	*80%*

B ex: Between Exercises; B G: Between groups, Int: *Intensity*.

Statistical Analysis:

Statistical analyses were conducted utilizing the SPSS 26 software for Windows (SPSS, Armonk, NY: IBM Corp, United States). Checks were made that the values of the data met the normal distribution using the Shapiro-Wilk test and the results showed that all the values met that distribution. Mean and standard deviations (SD) were obtained based on descriptive statistics, and between-group differences at baseline were compared using independent t-test analyses. To compare within-group performance differences between pre-intervention and post-intervention periods paired t-tests were conducted. The effects of the training-related changes were assessed by two-way analysis of variance (ANOVA) with repeated measurements of the group and time factors. If the major F-statistical values were obtained, Bonferroni's post hoc test was used to establish the comparability of major values. To compute the partial eta-squared to Cohen's d coefficient, the classification of effect size was used with lower threshold $0.00 \leq d \leq 0.49$ as small effect size, $0.50 \leq d \leq 0.79$ as medium effect size, and $d \geq 0.80$ as large effect size. Positive and negative differences were compared using a significance SPSS V26 used to analyze the data at a significance level of $p \leq 0.05$.

Results:

The study's examination of physiological and physical indicators in this study statistically significant alterations following the implementation of bungee cord and combat rope training for both the experimental and control groups, as illustrated Figure 1.2.

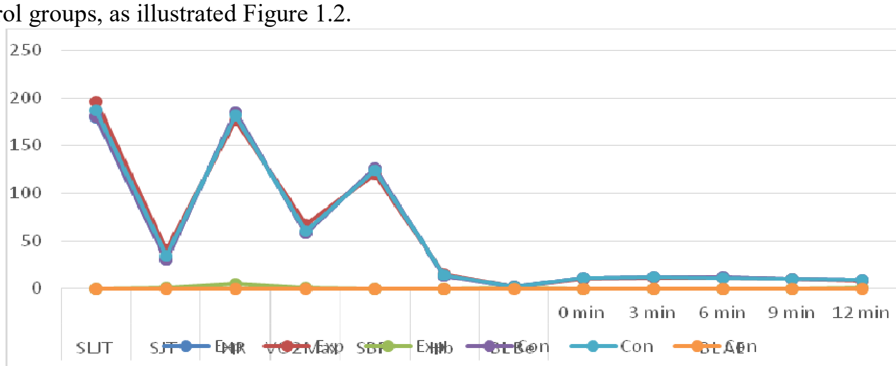

Figure 1 illustrates the pre- and post-measurements.

In a rigorous analysis utilizing paired-samples t-tests substantial evidence was established revealing significant differences between pre- and post-intervention measurements all assessed tests for experimental group, with p-values uniformly below the 0.05 threshold, detailed in Table 3. Physiological parameters demonstrated notable enhancement, as indicated by the percentage changes observed in heart rate (HR) by percentages (5.66%) and systolic blood pressure (SB) by percentages (6.39%), achieving statistical significance with $p < 0.001$. Furthermore, an evaluation of physical performance metrics illustrated marked improvements across various assessments, including Plank Test (PT)by percentages (19.39%), Medicine Ball Javelin test (MBJT)by percentages (37.39), and Sit Up test (SIUT)by percentages (41.07%) achieving statistical significance with $p < 0.001$. substantial evidence was established relatively significant differences between pre- and post-intervention measurements all assessed tests for control group, with p-values uniformly below the 0.05. Physiological parameters demonstrated notable enhancement, as indicated by the percentage changes observed in heart rate (HR) by percentages (2.63%) and systolic blood pressure (SB) by percentages (2.99%), achieving statistical significance with $p < 0.001$. Furthermore, an evaluation of physical performance metrics illustrated marked improvements across various assessments, including Plank Test (PT)by percentages (6.75%), Medicine Ball Javelin test (MBJT)by percentages (16.29), and Sit Up test (SIUT)by percentages (13.74%) achieving statistical significance with $p < 0.001$, threshold, detailed in Table 3.

Table 3. Descriptive statistics for experimental and control group.

Group	variables	Pre		post		t	95% CI		Sig.	Imp.
		Mean	SD	Mean	SD		Lower	Upper		
experimental	HR (bpm)	186.30	1.59	175.75	1.07	22.31	9.56	11.54	0.001	5.66
	SB (mmHg)	128.30	2.30	120.10	1.02	17.74	7.23	9.17	0.001	6.39
	PT(sec)	124.24	1.27	148.33	2.00	56.99	-24.98	-23.21	0.001	19.39
	MBJT(m)	5.75	0.16	7.90	0.34	30.40	-2.30	-2.00	0.001	37.39
	SIUT	15.95	0.89	22.50	0.95	27.90	-7.04	-6.06	0.001	41.07
control	HR (bpm)	186.50	1.47	181.60	1.47	13.54	4.14	5.66	0.001	2.63
	SB (mmHg)	128.65	2.21	124.80	1.36	15.15	3.32	4.38	0.001	2.99
	PT(sec)	124.35	1.24	132.74	1.79	21.38	-9.21	-7.56	0.001	6.75
	MBJT(m)	5.77	0.17	6.71	0.11	22.96	-1.03	-0.86	0.001	16.29
	SIUT (sc)	15.65	0.88	17.80	0.62	11.83	-2.53	-1.77	0.001	13.74

HR—Heart rate; SB— Systolic blood pressure; MBJT—Medicine Ball Javelin Test; PT—Plank test; 95% CI — 95% Confidence Interval of the Difference; Imp. — percentage improvement.

Table 4. presents the ANOVA results, F value concerning the primary related to measurement and group, and interaction influence. Also, the Partial Eta Squared (η^2) values have been incorporated in the table in their computed forms. The results of the Bonferroni post hoc test analysis pointed to significantly higher trends in increase of the incremental values in all the measured aspects among the participants in the experimental group than those in the control group. Also, the findings of this research showed that all the study variables yielded significant effects through the ANOVA test where $p<0.05$.

Table 4. The results of the Repeated Measures ANOVA.

variables	Measurement			Group			Group ×Time Interaction		
	F	P	η^2	F	P	η^2	F	P	η^2
HR (bpm)	673.15	0.001	0.947	82.42	0.001	0.684	90.02	0.001	0.703
SB (mmHg)	521.77	0.001	0.641	24.87	0.001	0.396	67.99	0.001	0.641
PT(sec)	3172.08	0.001	0.988	343.22	0.001	0.90	741.83	0.001	0.951
MBJT(m)	1430.91	0.001	0.974	118.91	0.001	0.758	216.26	0.001	0.851
SIUT(sc)	858.57	0.001	0.958	128.55	0.001	0.772	219.61	0.001	0.852

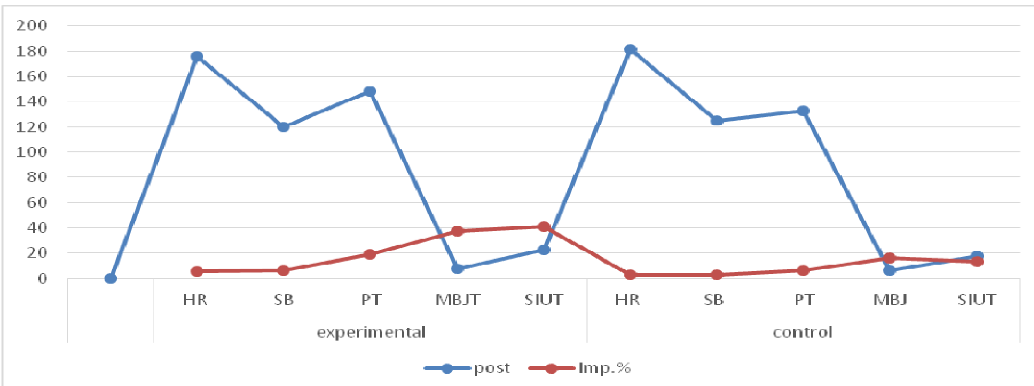

Figure 2. Presents the post-measurement outcomes the various tests administered to both the experimental and control.

Table 5. Provides a statistical comparison of the post-test values the experimental and control groups across physiological and physical indicators. Notably, the experimental exhibited significantly greater relative improvement rates across all metrics compared to the control group, with t-values indicating a high level of significance ($p < 0.001$). Specifically, the experimental group demonstrated enhancement in physiological indicators, with heart rate (HR) and systolic blood pressure (SB) improving by 3.03% and 3.4%, respectively. Moreover, the physical indicators also reflected substantial gains, with improvements observed in PT, 12.64%, MBJT, 21.15%, and SIUT, 27.33%.

Table 5. Experimental and Control groups measurements

variables	Levene's Test		t-test				95% CI		DIR
	F	Sig.	t	Sig.	Mean Difference	Std. Error Difference	Lower	Upper	
HR (bpm)	1.95	0.17	14.42	0.00	-5.85	0.41	-6.67	-5.03	3.03%
SB (mmHg)	3.93	0.05	12.35	0.00	-4.70	0.38	-5.47	-3.93	3.4%
PT(sec)	0.08	0.78	26.04	0.00	15.59	0.60	14.38	16.80	12.64%
MBJT(m)	35.28	0.00	14.91	0.00	1.19	0.08	1.02	1.35	21.15%
SIUT (sc)	5.73	0.02	18.62	0.00	4.70	0.25	4.19	5.21	27.33%

95% CI — 95% Confidence Interval of the Difference; DIR= Differences improvement rates.

Discussion

The study aimed to investigate the impact of Elastic and Battle Rope Training physiological and physical parameters on individual sports athletes over an eight-week duration. The findings reveal that thePartial Eta Squared (η^2) values reflect significant effect size for the regimen, with particularly high values for Heart Rate (HR) and (PT) at 0.947 and 0.988 respectively. This suggests that the training had a considerable impact on these variables. Additionally, the significant F-values for all measured variables (HR, SB, PT, MBJT, SIUT) demonstrate substantial changes in physiological and physical indicators. Elevated η^2 values for heart rate (HR) and (PT) a significant impact of training regimen (Correll et al., 2021). The consistently high F-values across all metrics—encompassing HR, systolic pressure (SB), (MBJT), (SIUT)—indicate pronounced physiological changes (Tang et al., 2021). Furthermore, the significant interaction effects suggest that performance improvements varied across different measurement periods, reflecting a dynamic response to the training interventions (Kirthika et al., 2019). The experimental group outperformed the control group across all metrics, underscoring the effectiveness of the training program. Moreover, the presence of significant interaction effects indicates that the performance improvements varied over time, suggesting that the training intervention had different levels of impact during various measurement periods. Suggest that the bungee cord and combat rope training had a notable positive effect on both physiological and physical performance in the experimental group relative to the control group, highlighting the efficacy of the training regimen across various indicators measured. Such robust changes underscore the potential benefits of these training methods in enhancing physical fitness outcomes. thereby reinforcing the effectiveness of bungee cord and combat rope training in enhancing overall physical fitness (Speer et al., 2020).

Resistance training (RT) has been shown to significantly reduce blood pressure (BP) and pulse rate, particularly in hypertensive populations. Various studies highlight the effectiveness of both traditional and isometric resistance training in achieving these outcomes. A meta-analysis indicated that RT alone can lead to significant reductions in systolic BP (−6.16 mmHg) and diastolic BP (−3.70 mmHg) among hypertensive individuals (Abrahin et al., 2021). Isometric resistance training (IRT) has also demonstrated clinically meaningful reductions in office BP, with decreases of approximately −6.97 mmHg for systolic and −3.86 mmHg for diastolic BP(Hansford et al., 2021). Consistent participation in these training methods can improve cardiovascular fitness, essential factor for combat athletes who need effective rate regulation and blood pressure management high-intensity competitions Grässler et., 2021; Kim et al., 2021). study found that battling rope exercise significantly elevated heart rate and sympathetic activity for up to 30 minutes post-exercise, alongside reductions in both systolic and diastolic blood pressure(Wong et al., 2020). Another investigation highlighted that participants engaging in progressive rope skipping exhibited decreased systolic and diastolic blood pressure after an 8-week training program, indicating enhanced cardiovascular fitness(Lin et al., 2023). The incorporation of rubber rope exercises and combat ropes has been proven to improve various physical attributes athletes, particularly in areas of strength, fitness, and overall performance. For instance, rubber rope exercises like skipping have been associated with enhancements in muscular strength and health among collegiate males showing significant improvements in VO2 max and movement screening scores following a 12-week training regimen (Kirthika et al., 2019). Additionally, a jump rope-based program illustrated considerable gains in muscular strength and flexibility among adolescents, suggesting that similar resistance-based exercises are effective in promoting physical fitness (Yang et al., 2020).

Elastic and battle rope training can significantly enhance parameters associated with power, and endurance athletic training regimens The unique characteristics of these training when effectively integrated into athlete's routine, may lead to improved outcomes. For instance, research involving basketball players demonstrated that battle rope exercises increased blood rate levels and perceived exertion, indicating a high-intensity workout; however, there was a noted reduction in shooting accuracy and pass speed, suggesting that this form of training may be more beneficial for conditioning rather than pre-competition performance (Chen et al., 2020). In another study, junior handball players who engaged in an 8-week elastic band-based plyometric training program exhibited improvements in sprint velocity and dynamic stability, when compared to control groups (Aloui et al., 2020). Additionally, Negra et al. (2019) reported that young soccer players of both genders showed improved speed in change of direction, sprinting, and both horizontal and vertical jumps following an 8-week plyometric training program conducted twice per week using weight vests. Similarly, Kobal et al. (2017) found that young male soccer players experienced enhancements in sprinting and vertical jumping capabilities after six weeks of bi-weekly plyometric training with handheld dumbbells. Collectively, these studies underscore the efficacy of resistance-based training modalities in optimizing athletic performance.

Study Limitations

While the findings of this study are significant, it is essential to acknowledge several methodological limitations. First, the sample size was relatively small, which limits the ability to generalize the results to a broader population of athletes. A larger and more diverse would be needed to enhance the external validity of the findings. Second the study did not account for various lifestyle factors that could influence the outcomes, including dietary habits, sleep quality, and the use of devices. These factors can significantly affect athletic performance and recovery, and their lack of control may introduce confounding variables that could skew the results. Without a systematic assessment of these elements, it remains challenging to isolate the specific effects of the training interventions implemented in this study. Addressing these limitations in future research would provide a more comprehensive understanding of the impact of Elastic and Battle Rope Training on athletic performance.

Conclusion:

In conclusion, the outcomes of this study indicate significant enhancements both physiological and physical indicators from the 8 Elastic and Battle Rope Training. Moreover, substantial improvements were observed in autonomic markers, including heart rate (HR) and systolic blood pressure (P). These findings the viability of Elastic and Battle Rope Training. as an effective approach to enhancing athletic performance, demonstrating its applicability across various sports disciplines. Muscle strength also improves as a result of using these exercises. Furthermore, the results align with previous research, which similarly indicated superior performance metrics in the experimental group compared to the control group. Given the positive contributions of Elastic and Battle Rope Training to athletes' physical performance, there is an opportunity to further develop training programs tailored to meet the needs of diverse athletic populations. Future research could expand upon this study by examining long-term effects of such training regimens on different populations, including youth athletes and elite competitors. Moreover, the research spectrum can be broadened to examine how programs that incorporate elastic and battle ropes influence facets of athletes' performance across different. This includes exploring the integration such training with athletes' dietary and overall lifestyle. Additionally, it be beneficial to assess' visual endurance and coordination skills while utilizing ropes during training sessions. Finally, investigations focused on how the duration and intensity of training affect both biochemical and psychological outcomes are warranted. Analyzing these variables would provide valuable scientific insights to advocate for the inclusion of elastic and battle ropes in athletes' training regimens, thereby improving the effectiveness of sport training in enhancing both physical and psychological performance.

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Informed Consent Statement: All subjects who were included in the research had given their consent to participate in the research.

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Conflicts of Interest: The authors declare no conflict of interest.

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