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Comparison of the Effects of Two Types of Resistance Training Using Weights or Bands on Upper Body Strength and Endurance in 14- to 16-Year-Old Male Students

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Abstract:

Background: The aim of the current research is to find out whether exercises with bodybuilding Elastic bands have the same effects on the strength and endurance of upper body muscles as exercises with weights or not. It can help people who cannot do their daily weight training for many reasons, Therefore, if the results obtained from Exercise with elastic bands were close to the results of weight training, When these people are unable to use gyms, we can offer them elastic bands exercises So that they do not fall behind their goal and training plan.

Methods: In this study, we selected 24 male students aged 14 to 16 and divided them into two groups of 12. The first group performed resistance exercises with weights and the second group performed the same exercises that were simulated with 5-string CX bands. After the completion of 8 weeks of training, the results obtained from the strength item showed that in the movements of The Neck Lat Pull Down, Machine Shoulder Press, and Biceps Incline Curl, the performance in the weight training group was better than the elastic bands training group. However, there was no significant difference between the two groups in the movement of the chest press.

Results: There was a significant difference between the effect of resistance exercises with weights and elastic bands on the endurance of upper body muscles in swimming, sit-ups and bar-fix movements.

Conclusion: It means that in these three items, the weight training group performed better than the stretch training group. However, there was no significant difference between the two groups in Plank's movement.

Key words: strength training, endurance training, training with Elastic bands, weight training.

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Introduction

In today's world, the lifestyles of many adolescents have undergone fundamental changes due to the rapid advancement of technology, (1) increased use of virtual platforms, reduced physical activity, and especially the global crisis caused by the COVID-19 pandemic in recent years. (2) The closure of schools, prolonged home confinement, and lack of proper environments for physical activity have led to decreased physical fitness, (3) weight gain, lowered morale, and the emergence of metabolic issues among many teenagers. One of the direct consequences of this situation is the decline in muscular strength and endurance among adolescents. (4) The human body requires a minimum level of regular physical activity to maintain optimal function in daily life. (5) Without it, muscles gradually weaken, and the body becomes increasingly susceptible to various diseases such as diabetes, obesity, musculoskeletal disorders, and even mental health issues. (6)

In such circumstances, resistance training is recognized as one of the most effective strategies for enhancing muscular strength and endurance. (7) These exercises can be performed using traditional weights or simpler tools such as resistance bands. (8) Weight training is typically done in gyms and, due to the use of machines and various loads, has a strong impact on muscle growth. However, in recent years, resistance band training has gained attention as a low-cost, portable, and home-friendly alternative. This leads to a key question: Can resistance band exercises offer the same effectiveness as weight training? Is it possible to recommend resistance bands to adolescents who lack access to gyms, without compromising the quality or impact of their training program?

This study was designed to explore this question in depth. We aimed to investigate and compare the effects of two types of resistance training—one using weights and the other using resistance bands—on the upper-body strength and muscular endurance of male students aged 14 to 16. This age range is a critical period in physical development, where appropriate or inappropriate interventions can have long-term impacts on an individual's overall health and physical well-being. It is hoped that the results of this study can offer practical and scientific guidance to families, coaches, physical education teachers, and professionals in exercise science, helping them support adolescents in maintaining and improving their physical fitness under varying circumstances.

Method

This study adopted a quasi-experimental design with a pretest-posttest approach and no control group. The aim was to compare the effects of two types of resistance training—using free weights and resistance bands—on upper-body muscular strength and endurance in adolescent boys aged 14 to 16. (9) A total of 24 male students from Salihin High School in Isfahan, Iran, were selected

through convenience sampling. Eligibility criteria included being in good general health, having no musculoskeletal injuries or chronic conditions,(10) and no history of regular resistance training in the past six months.

After obtaining written informed consent from both the students and their parents, participants were randomly assigned into two equal groups: one group trained with weights and the other with resistance bands (using CX five-band system). Both groups followed the same structured training program targeting the upper-body muscle groups—including the chest, biceps, shoulders, and back. The training lasted for eight weeks, with three sessions per week, each lasting approximately 90 minutes. Exercise intensity was set at 75% to 85% of the participant's estimated one-repetition maximum (1RM), and it was gradually increased throughout the program to maintain the principle of progressive overload.

To assess the outcomes, a series of standardized strength and endurance tests were conducted before and after the intervention. Strength was measured using estimated 1RM tests for bench press, biceps curl, shoulder press, and lat pull-down. Endurance was assessed using timed or maximum-repetition tests, including push-ups (30 seconds), sit-ups (60 seconds), pull-ups (to fatigue), and a plank hold (duration). All assessments were carried out under controlled conditions in the school gym and supervised by a qualified instructor to ensure safety and consistency.

The training equipment included dumbbells, barbells, and resistance machines for the weight group, while the resistance band group used CX five-band systems with varying tensions (10 to 30 pounds), used individually or in combination depending on the participant’s capacity.

Statistical Analysis

Data analysis was performed using SPSS version 26. The Shapiro–Wilk test was used to confirm the normal distribution of variables, and Levene’s test was applied to check for homogeneity of variances. Between-group differences in post-test results were analyzed using multivariate analysis of covariance (MANCOVA), with a significance level set at $p < 0.05$.

Ethical considerations were fully observed. All participants voluntarily took part in the study, and written informed consent was obtained in accordance with research ethics protocols.

Results

Upper Body Muscle Strength:

The descriptive analysis of upper body muscle strength revealed that both intervention groups—resistance training with weights and resistance training with elastic bands—experienced noticeable improvements in their mean scores after completing the eight-week training program. Strength was assessed through four key exercises: bench press, biceps curl, shoulder press, and lat pulldown (Table 1). The results indicated that in three exercises—lat pulldown, shoulder press, and biceps

curl—the group trained with free weights outperformed the band-trained group. This may reflect the superior effectiveness of external load resistance in enhancing targeted muscle strength (11). In contrast, for the bench press, although both groups showed progress, the between-group difference was not statistically significant. This could be attributed to a relatively similar muscular adaptation in response to both training modalities, especially for the pectoral muscles.

Overall, while resistance training with elastic bands did contribute to improvements in upper body strength, the group using free weights demonstrated a more pronounced enhancement across most measures. These differences in muscular adaptation might stem from the mechanical characteristics of weight training, including higher direct mechanical tension and greater recruitment of motor units (12).

Table1. The descriptive analysis of upper body muscle strength.

Items	Group	Number	Pre-test		Post-test		Average percentage of progress
			Mean	SD	Mean	SD	
chest press	Weight training	12	38/83	10/41	57/66	10/38	52/10
	Practice with cache	12	39/66	16/63	54/33	15/98	51/13
Lat	Weight training	12	41/58	9/19	47/66	9/23	15/62
	Practice with cache	12	38/16	11/06	42/00	11/15	10/80
shoulder	Weight training	12	27/75	6/48	46/00	8/17	69/75
	Practice with cache	12	22/50	9/28	32/83	10/11	56/62
Bicep	Weight training	12	23/58	8/06	33/83	8/35	65/14
	Practice with cache	12	21/58	7/06	27/33	6/99	36/03

Table 2 provides a detailed look at the participants' performance in upper body muscular endurance exercises, including push-ups**,** plank**,** sit-ups, and pull-ups. While both training groups showed improvement after the intervention, the weight training group generally performed better in three out of the four exercises. For instance, in the pull-up test, participants who trained with weights improved by 78.47%**,** compared to just 31.76% in the band training group. In the case of the plank exercise, although the weight training group recorded a higher average time, the difference between the two groups was not statistically significant.

Table2. Performance in upper body muscular endurance exercises

Items	Group	Number	Pre-test		Post-test		Average percentage change
			Mean	SD	Mean	SD	
press-up	Weight training	12	12/25	7/62	16/00	8/44	41/09
	Practice with cache	12	13/41	8/80	15/58	9/49	38/22
Planck	Weight training	12	88/25	49/68	136/16	64/48	60/92
	Practice with cache	12	135/91	56/49	190/91	64/07	50/50
sit-up	Weight training	12	34/58	11/47	45/66	12/14	35/22
	Practice with cache	12	34/66	20/37	43/41	20/87	35/07
Pull-up	Weight training	12	1/58	1/56	3/00	2/37	78/47
	Practice with cache	12	2/83	2/97	3/75	3/64	31/76

Inferential Analysis

Multivariate Analysis of Covariance (MANCOVA) – Strength Variables

To compare the effects of the two training methods on upper body strength, a multivariate analysis of covariance (MANCOVA) was conducted. The results, summarized in Table 3, indicated that there were statistically significant differences between the two groups in three out of four strength variables. In other words, the weight training group outperformed the band training group in most strength measures. The differences were significant for lat pulldown ($F = 14.27$, $p < 0.001$), shoulder press ($F = 47.68$, $p < 0.001$), and biceps curl ($F = 33.74$, $p < 0.001$). However, in the bench press test, no significant difference was observed between the two groups ($F = 2.75$, $p = 0.11$).

Table3. Statistically significant differences between the two groups in three out of four strength variables

Source	Variable	Sum of Squares	df	Mean Square	F	p-value	Effect Size	Power
Covariate	**Bench Press**	662.28	1	662.28	89.35	0.001	0.83	1.00
	Lat Pulldown	355.87	1	355.87	321.80	0.001	0.94	1.00
	Shoulder Press	228.28	1	228.28	58.46	0.001	0.76	1.00
	Biceps Curl	247.51	1	247.51	127.04	0.001	0.87	1.00
Group	**Bench Press**	20.43	1	20.43	2.75	0.11	0.13	0.34
	Lat Pulldown	15.78	1	15.78	14.27	0.001	0.44	0.94
	Shoulder Press	186.18	1	186.18	47.68	0.001	0.72	1.00
	Biceps Curl	65.75	1	65.75	33.74	0.001	0.65	1.00
Error	**Bench Press**	133.41	18	7.41				
	Lat Pulldown	19.90	18	1.10				
	Shoulder Press	70.28	18	3.90				
	Biceps Curl	35.06	18	1.94				

The results of the MANCOVA for upper body muscular endurance variables are presented in Table 4. Significant differences were found between the two groups in push-ups ($F = 18.54$, $p < 0.001$), sit-ups ($F = 6.98$, $p = 0.017$), and pull-ups ($F = 7.34$, $p = 0.014$), all favoring the weight training group. These findings suggest that participants who trained with weights achieved better overall endurance performance in these exercises compared to those who trained with resistance bands. However, for the plank exercise, no significant difference was observed ($F = 1.24$, $p = 0.27$), indicating that both training methods had a similar impact on isometric muscular endurance in this particular test.

Table4. Presented upper body muscular endurance variables.

Source	Variable	Sum of Squares	df	Mean Square	F	p-value	Effect Size	Power
Covariate	**Push-ups**	436.86	1	436.86	512.01	0.001	0.96	1.00
	Plank	16521.74	1	16521.74	23.28	0.001	0.56	0.99
	Sit-ups	1792.80	1	1792.80	284.58	0.001	0.94	1.00
	Pull-ups	38.19	1	38.19	165.02	0.001	0.90	1.00
Group	**Push-ups**	15.81	1	15.81	18.54	0.001	0.50	0.98
	Plank	883.12	1	883.12	1.24	0.27	0.06	0.18
	Sit-ups	44.00	1	44.00	6.98	0.017	0.28	0.70
	Pull-ups	1.70	1	1.70	7.34	0.014	0.29	0.72
Error	**Push-ups**	15.35	18	0.85				
	Plank	12774.22	18	709.67				
	Sit-ups	113.39	18	6.30				
	Pull-ups	4.16	18	0.23				

Discussion

The primary aim of this study was to compare the effects of two types of resistance training—weight training and elastic band training—on upper body strength and muscular endurance in adolescent boys. (13) The findings indicated that while both training methods led to improvements in performance, weight training generally resulted in greater gains across most variables. (14) Regarding upper body strength, the multivariate analysis of covariance revealed that the weight training group outperformed the band training group in three out of four strength tests (lat pulldown, shoulder press, and biceps curl). This superiority may be attributed to the higher mechanical load associated with weight training, which, according to physiological principles, (15) provides a greater neuromuscular stimulus and promotes muscle hypertrophy more effectively than resistance bands. (16)

In terms of muscular endurance, both groups showed noticeable improvement, (17) but once again, the weight training group achieved better results in push-ups, sit-ups, and pull-ups. Interestingly, no significant difference was observed in the plank test, which involves isometric endurance. This may suggest that in static exercises like planks, other factors such as core stability, breathing control, (18) and mental endurance play a more prominent role, reducing the impact of the type of resistance used. (5) These findings are consistent with previous studies, many of which have shown that weight-based resistance training tends to yield greater strength and endurance gains, particularly in adolescents who are still in their developmental stage and may respond more

robustly to higher resistance stimuli. Nevertheless, it is important not to overlook the advantages of elastic band training. Resistance bands offer several benefits, including portability, affordability, and reduced joint stress, making them a valuable tool for educational settings, rehabilitation programs, or beginners. Although weight training proved more effective in this study, elastic bands remain a practical and effective alternative under certain conditions (19). Finally, this study had some limitations, including a relatively small sample size and the lack of long-term follow-up after the intervention. Future research could explore longer training durations, different age or gender groups, and combined resistance methods to provide a more comprehensive understanding of the effects of resistance training modalities. This study provides strong evidence that resistance training—whether with traditional free weights or resistance bands—can significantly improve upper-body muscular strength and endurance in adolescent boys. (13) However, the data clearly suggest that training with free weights leads to greater improvements across most performance measures, (14) especially in strength-based exercises such as shoulder press, lat pull-down, and biceps curl. While resistance bands also showed positive effects, their impact was generally less pronounced. Nevertheless, their portability, safety, and affordability make them a valuable alternative for settings where free weights are unavailable or impractical—such as schools, homes, or during lockdown periods. It is important to highlight that both training modalities were effective in improving physical fitness in this age group, and that structured resistance training (20)—even in youth—can be safely implemented with proper guidance. This is particularly relevant considering the increasing rates of physical inactivity and sedentary behaviors among teenagers.

Conclusion

In conclusion, although free weights appear more effective overall, resistance bands remain a valid and practical option. Fitness professionals, educators, and policymakers should consider both methods when designing adolescent training programs, and tailor the approach to individual needs, access to equipment, and training goals. Ultimately, promoting consistent and enjoyable physical activity is far more valuable than focusing on one training modality over another. (21)

References

1. Mourtzis D, Angelopoulos J, Panopoulos N. A Literature Review of the Challenges and Opportunities of the Transition from Industry 4.0 to Society 5.0. Energies. 2022;15(17):6276.
2. Vandoni M, Codella R, Pippi R, Carnevale Pellino V, Lovecchio N, Marin L, et al. Combatting sedentary behaviors by delivering remote physical exercise in children and adolescents with obesity in the COVID-19 era: a narrative review. Nutrients. 2021;13(12):4459.

3. Chaabane S, Doraiswamy S, Chaabna K, Mamtani R, Cheema S. The impact of COVID-19 school closure on child and adolescent health: a rapid systematic review. Children. 2021;8(5):415.
4. dos Reis AL, de Oliveira LC, de Souza AYV, Stabelini Neto A, de Oliveira RG. Effects of stretching on muscle strength, endurance, and power performance: A systematic review and meta-analysis. Isokinetics and Exercise Science. 2024;32(3):181-97.
5. Martín-Rodríguez A, Gostian-Ropotin LA, Beltrán-Velasco AI, Belando-Pedreño N, Simón JA, López-Mora C, et al. Sporting mind: the interplay of physical activity and psychological health. Sports. 2024;12(1):37.
6. D'Onofrio G, Kirschner J, Prather H, Goldman D, Rozanski A. Musculoskeletal exercise: Its role in promoting health and longevity. Progress in Cardiovascular Diseases. 2023;77:25-36.
7. Fyfe JJ, Hamilton DL, Daly RM. Minimal-dose resistance training for improving muscle mass, strength, and function: a narrative review of current evidence and practical considerations. Sports Medicine. 2022;52(3):463-79.
8. Liu X, Gao Y, Lu J, Ma Q, Shi Y, Liu J, et al. Effects of different resistance exercise forms on body composition and muscle strength in overweight and/or obese individuals: a systematic review and meta-analysis. Frontiers in physiology. 2022;12:791999.
9. Stricker PR, Faigenbaum AD, McCambridge TM, Medicine CoS, Fitness, LaBella CR, et al. Resistance training for children and adolescents. Pediatrics. 2020;145(6):e20201011.
10. Bonfiglioli R, Caraballo-Arias Y, Salmen-Navarro A. Epidemiology of work-related musculoskeletal disorders. Current Opinion in Epidemiology and Public Health. 2022;1(1):18-24.
11. Hung C-H, Su C-H, Wang D. The Role of High-Intensity Interval Training (HIIT) in Neuromuscular Adaptations: Implications for Strength and Power Development—A Review. Life. 2025;15(4):657.
12. Lambrianides Y, Epro G, Smith K, Mileva KN, James D, Karamanidis K. Impact of different mechanical and metabolic stimuli on the temporal dynamics of muscle strength adaptation. The Journal of Strength & Conditioning Research. 2022;36(11):3246-55.
13. Smoak Y. Effects of Free-weight with and without Elastic Band Tension on Upper-Body Strength and Muscular Endurance: A Randomized Parallel Trial. Journal of Strength and Performance. 2022;1(1).
14. Suchomel TJ, Nimphius S, Bellon CR, Hornsby WG, Stone MH. Training for muscular strength: Methods for monitoring and adjusting training intensity. Sports Medicine. 2021;51(10):2051-66.
15. Lawson D, Vann C, Schoenfeld BJ, Haun C. Beyond mechanical tension: A review of resistance exercise-induced lactate responses & muscle hypertrophy. Journal of Functional Morphology and Kinesiology. 2022;7(4):81.
16. Fink J, Schoenfeld BJ, Sakamaki-Sunaga M, Nakazato K. Physiological responses to agonist–antagonist superset resistance training. Journal of Science in Sport and Exercise. 2021;3:355-63.
17. Hammer S, Toussaint M, Vollsæter M, NESBJØRG M, Røksund OD, Reychler G, et al. Exercise training in Duchenne muscular dystrophy: A systematic review and meta-analysis. Journal of rehabilitation medicine. 2021;54:985.
18. Silian X, Zainudin Z. Articulating Core Strength Training in Physical Education. ICCCM Journal of Social Sciences and Humanities. 2025;4(1):41-51.
19. Dyshko O, Kosynskyi E, Sitovskyi A, Chodinow W, Pasichnik V. The Analysis of Effectiveness of Elastic Training (Resistant) Bands Application to Develop Explosive Strength. Health, sport, rehabilitation. 2021;7(3):43-53.

20. Versic S, Idrizovic K, Ahmeti GB, Sekulic D, Majeric M. Differential effects of resistance-and endurance-based exercise programs on muscular fitness, body composition, and cardiovascular variables in young adult women: contextualizing the efficacy of self-selected exercise modalities. Medicina. 2021;57(7):654.
21. Wintle J. Physical education and physical activity promotion: lifestyle sports as meaningful experiences. Education Sciences. 2022;12(3):181.