Physical Education, Health and Social Sciences

https://journal-of-social-education.org

E-ISSN: 2958-5996
P-ISSN: 2958-5988

Effects of Low Repetition Resistance Training Protocol and High Repetition Resistance Training Protocol On the Muscular Fitness of Preadolescents

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DOI: https://doi.org/10.63163/jpehss.v3i2.287

Abstract

The objective of this study was to examine the effects of two different resistance training protocols, low-repetition (6–8) and high-repetition (13–15), on muscular fitness in preadolescents. The results indicated that both protocols were effective in improving the strength and endurance of the subjects, but the low repetition protocol resulted in greater improvements in the maximal strength (1 RM squat and overhead press) and the high repetition protocol led to the improvement of the muscular endurance (knee push up), explosive power (standing long jump and medicine ball throw). There was a gender effect, as males displayed greater increases in strength, and females showed characteristic relative increases in endurance. Overall, both training protocols in the study effectively improved preadolescent muscular fitness, emphasizing the significance of implementing proper training protocols according to the fitness goals. Lastly, this study offers new perspectives on how resistance training could be adjusted to best prevent injuries and improve growth during childhood and adolescence.

Keywords: Low Repetition, High Repetition, Resistance Training Protocol, Muscular Fitness, Preadolescents.

Introduction

For healthy growth of children, it is vital to be physically active during childhood. Across the globe, kids are enjoying sports and physical activities. These games are based on simple motor skills such as running, jumping, catching, kicking and other forms of movement that contribute to healthy development of kids. Being active from a young age in physical activities, promotes the development of core movement competencies which are essential for long-term sporting success and overall health. Aerobic activities such as cycling and running for children are generally considered safe. The activities help in the development of cardiovascular fitness, endurance, and mental well-being, which is why these activities are recommended by many health organizations. Despite the abundant evidence proving the health benefits associated Children's Resistance Training, major portion of the population believes that such form of exercise is dangerous for children and can "stunt" their growth. The idea that lifting weights is harmful to children's growth comes from outdated thinking, not scientific studies. This myth has long been debunked by exercise scientists (Lloyd & Myer, 2016) and, over the years, resistance training is also becoming of interest for children as they become more mainstream. There's modern research that supports this idea, and if properly supervised and tailored to children's abilities, resistance training can be an excellent form of exercise It has the potential to aid in strengthening your muscles and ligaments, increase your bone density, develop neuromuscular proficiency, prevent injuries, and even maintain your mobility. Moreover, resistance training provides several psychological merits, including improved self-image, reduced anxiety, and enhanced concentration in academic and extracurricular pursuits (Ramsay et al., 1990).There are several forms of resistance training that can be incorporated in a children's fitness program, depending on their age and training goals:

1. Resistance Bands involve elastic bands in your therapy activities to allow for adjustable resistance, making them a safe and effective choice for developing strength and coordination in children.
2. Suspended Training involves straps and the body, for dynamic movements that improve core strength, balance, and stability.
3. Bodyweight Training — exercises such as push-ups and squats using the child's own body to develop basic strength with no equipment.
4. The free weights training uses light dumbbells or kettlebells to build up muscular strength and control, with a particular focus on form.
5. Machine-Based Training — Uses resistance machines that guide movement, useful for beginners, but must be properly sized and supervised for kids.
6. Isometric Training: Involves holding static positions (like planks or wall sits) to enhance muscular endurance and stabilizes the joints.
7. Plyometric Training — Consisting of explosive dynamic joint actions, such as jumping and bounding, which develop power and agility, plyometric training can enhance cardiovascular fitness as well, and should be supervised and done in conjunction with a developmentally appropriate program.

Resistance training in the youth population has gone through a paradigm shift over the past century, as what was once considered a widely feared practice that is met with medical reluctance and disbelief has transitioned into a scientifically validated and evidence-driven approach to fitness, as endorsed by a multitude of professional organizations. Historically, myths based on a lack of empirical understanding have led to child resistance training being traditionally considered inappropriate and potentially dangerous. Yet, over the ensuing 50+ years, as the science of exercise has evolved, extensive data has resoundingly dispelled these myths and established resistance training as a safe, effective, and critical element of youth physical development. From the latest evolution, debate, and status in resistance training for children, to the emergence of a range of protocols developed to optimize the process to deliver rewards to enhance safety and effectiveness. In the early 20th century resistance training was typically discouraged by public opinion and medical experts for children. The most common perception was that strength training could harm epiphyseal growth plates in youngsters, resulting in growth cessation and permanent short stature (Lloyd et al., 2014). This myth probably originated in isolated injury reports that lacked scientific context. Medical authorities have long warned parents and school officials that strength training is risky for young people, insisting muscle growth should come without the use of weights. With considerations for possible growth plate damage being a primary concern, as well as the contention that children do not possess the right hormonal profile to benefit from resistance training, especially testosterone (Faigenbaum & Myer, 2016), they were dissuaded from participation in this obviously beneficial training modality. From this premise, strength training was thought to be useless until after puberty. These beliefs were backed by anecdotal reports, limited physiologic studies and an absence of research on exercise in children.Fears about injury risk made resistance to youth strength training even more entrenched. Parents and practitioners feared that performing these movements would put undue stress on developing musculoskeletal systems, heighten the risk of fractures, and lead to chronic conditions.

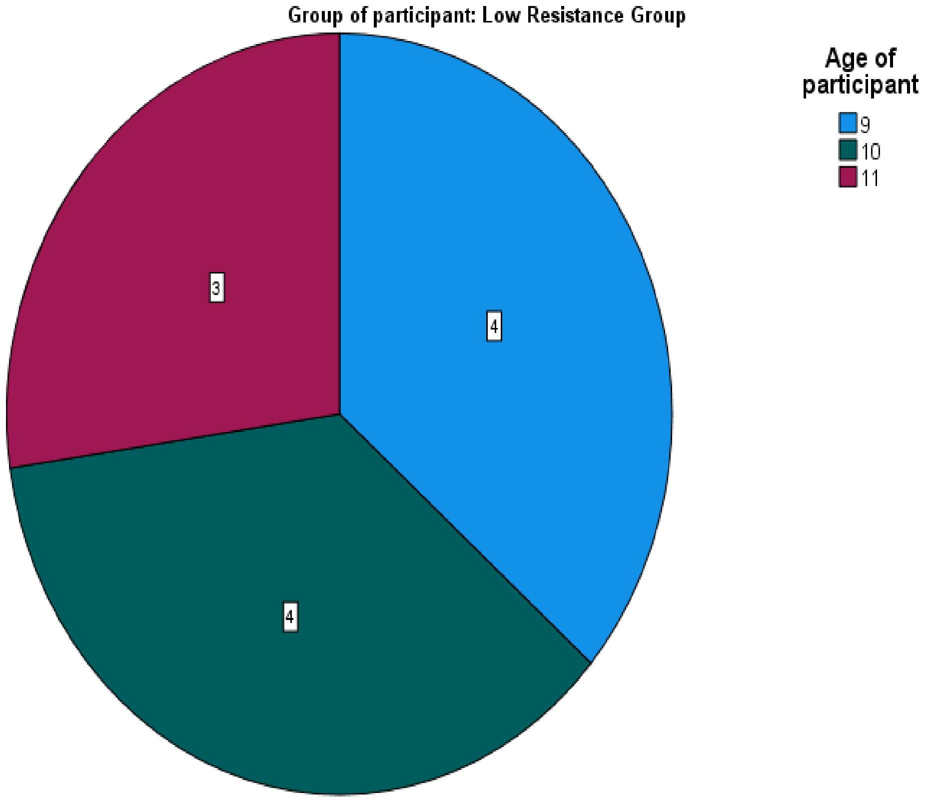
The study was carried out at Umar Grammar School Lahore, which possessed various resources fit for the project. Designed with several weight training items including dumbbells, resistance bands, medicine balls, and kettlebells, the basement hall was utilised for kid training sessions Gillani, S. M. B., & Aslam, S. (2023) .The study sought to ascertain how preadolescent adolescents (9–12 years old) responded to a low resistance training program (6–8 repetitions) and a high resistance training program (13–15 repetitions). Measuring the children's muscular fitness both pre- and post-twelve-week resistance training programs, the study was conducted under a quasi-experimental design. The 12-week training regimen consisted in two weekly resistance training sessions. For the Low Resistance Training Group, each session ran 40 to 50 minutes; for the High Resistance Group, the intensity ranged from 50 to 60 percent of 1RM. Mondays and Thursdays were the training days; each started with a five-minute warm-up then spent ten minutes dynamically stretching. Two sets of squats, lunges, overhead press, and triceps dumbbell movements sometimes referred to as skull crushers comprised the major workouts. Each exercise in the Low Resistance Training Group was done six to eight times, while in the High Resistance Training Group it was done 13 to 15 times. Every week, a little overload was administered mostly through pauses and tempo adjustments in the workouts. The weights utilised in the last weeks were somewhat higher. Parents' consent was sought, and the children's medical histories were documented to guarantee their health condition would enable them to participate in the study. Six separate tests—squat, overhead press, wall sit, standing long jump, medicine ball toss (5 kg weight), and knee push-ups—made up a pre-test. Following the 12-week training program, both groups had a post-test analysis employing the same tests to gauge development. With 11 individuals in each group, the research comprised 22 preadolescents (9–12 years old). Participants falling between the ages of 9 and 12 were chosen using convenient sampling. Children aged 9 to 12 years, without musculoskeletal injuries or medical issues that would prevent involvement in resistance training, and who were willing to participate in the study and follow the training guidelines comprised the study's inclusion criteria. Children whose parental permission could not be acquired and those with contraindications to resistance training as judged by a medical practitioner were excluded. Descriptive statistics and paired sample t-tests were applied in statistical analysis. Using the Statistical Package for the Social Sciences (SPSS), version 23, every statistical analysis was conducted with an alpha level of 0.05 setting statistical significance.

Data collection

Data for this study were collected at two points: pre-intervention and post-intervention. Muscular strength and endurance were measured using specific tests. The One-Repetition Maximum (1RM) Squat and the One-Repetition Maximum (1RM) Ali, B., Gillani, S. M. B., & Butt, M. Z. (2022) Overhead Press were used to assess lower and upper body strength, respectively. Additionally, muscular endurance was measured using the Wall Sit and Knee Push-ups, while power was assessed with the Medicine Ball Throw. All participants were tested at the beginning of Week 1 (pre-intervention) and again at the end of Week 12 (post-intervention) These tests were conducted under controlled conditions, ensuring the same equipment and procedures were used for both the low resistance and high resistance groups. For the 1RM tests, participants completed warm-up sets with lighter weights before attempting their maximum single lift. The Medicine Ball Throw involved participants performing a maximal throw with a 5kg medicine ball, and for the Wall Sit, participants held the position for as long as possible. The Knee Push-ups were performed until failure to assess muscular endurance. All tests were carried out consistently at both time points to ensure reliable and valid results.

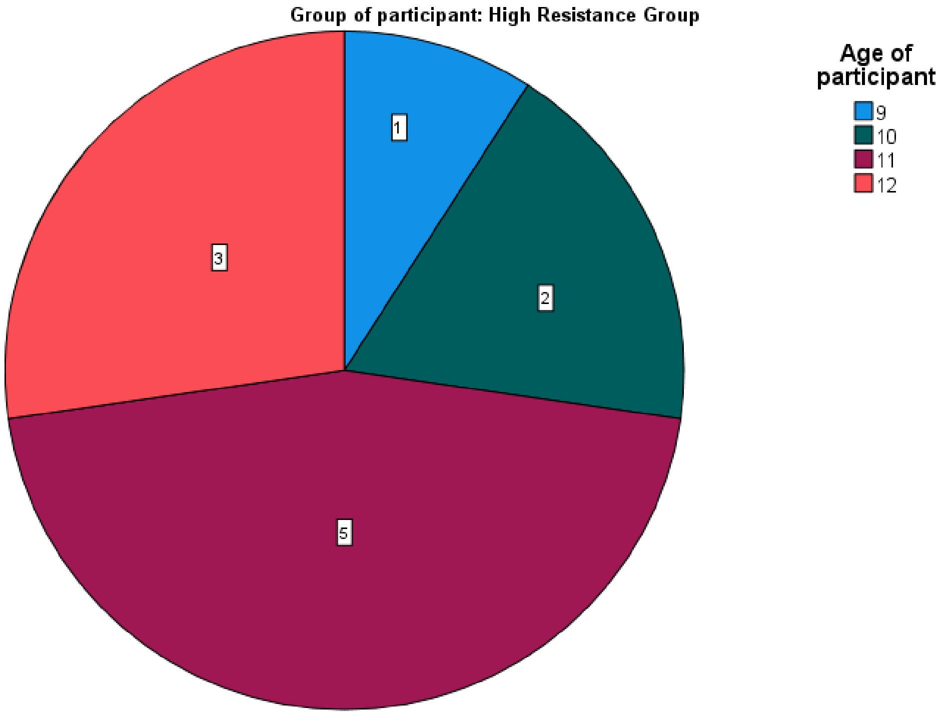
Figure 1

Age distribution of the participants of Low Resistance Group.



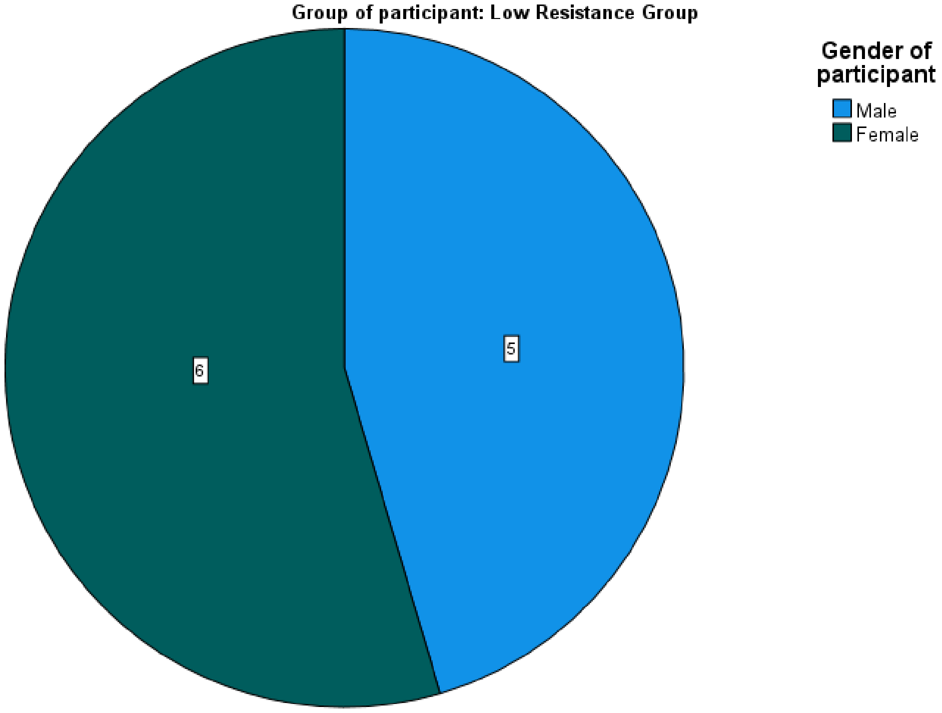
Note. This figure shows the age distribution of the participants of low resistance group.

Figure 2
Age distribution of the participants of High Resistance Group.



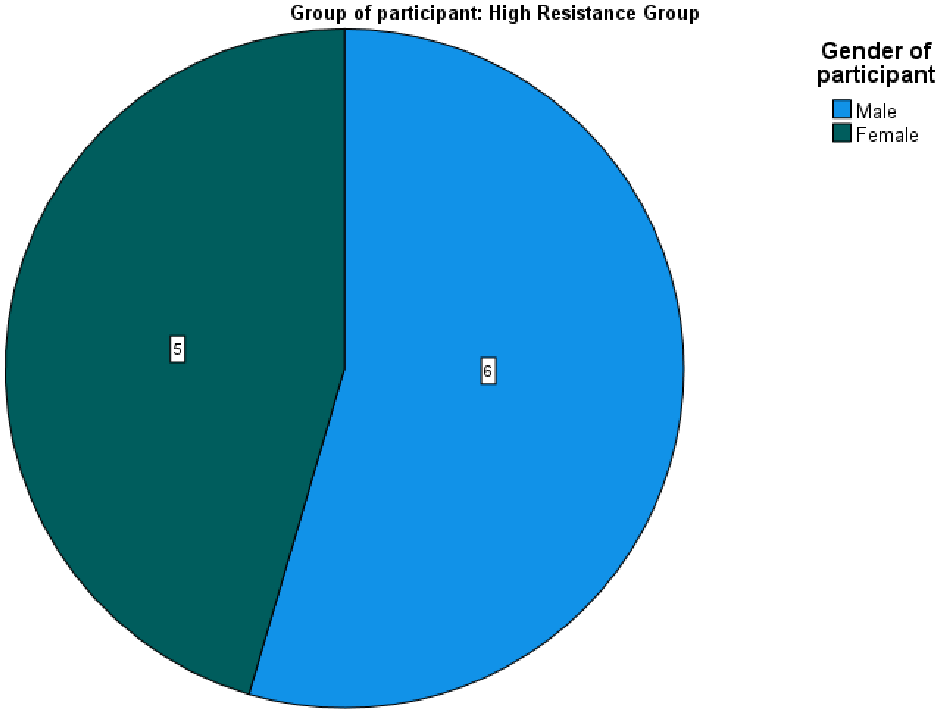
Note. This figure shows the age distribution of the participants of high resistance group.

Figure 3
Gender distribution of the participants of Low Resistance Group.



Note. This figure shows the gender distribution of the participants of low resistance group.

Figure 4
Gender distribution of the participants of High Resistance Group.



Note. This figure shows the gender distribution of the participants of high resistance group.

Table 1
Normality of the data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
1RM (Squat) before 12WRTP	.135	22	.200*	.971	22	.730
1RM (Squat) after 12WRTP	.114	22	.200*	.960	22	.485
SLJ before 12WRTP	.147	22	.200*	.953	22	.367
SLJ after 12WRTP	.165	22	.122	.940	22	.194
WS before 12WRTP	.083	22	.200*	.968	22	.670
WS before 12WRTP	.104	22	.200*	.965	22	.586
OHP before 12WRTP	.142	22	.200*	.948	22	.293
OHP after 12WRTP	.170	22	.096	.937	22	.172
MBT before 12WRTP	.139	22	.200*	.940	22	.196
MBT after 12WRTP	.157	22	.171	.912	22	.051
KPU before 12WRTP	.169	22	.104	.937	22	.172
KPU after 12WRTP	.154	22	.192	.929	22	.117

Note. Table 1 shows normality of the data which was assessed using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. For all variables, including 1RM squat, standing long jump (SLJ), wall sit (WS), overhead press (OHP), medicine ball throw (MBT), and knee push-ups (KPU), both before and after the 12-week resistance training protocol (12WRTP), the significance (Sig.) values in both tests are greater than 0.05. This indicates that the data for each variable is normally distributed. Therefore, parametric tests such as the paired sample t-test or independent sample t-test can be appropriately used for further statistical analysis.

Table 2

Paired Samples Statistics of Low Resistance Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1RM (Squat) before 12WRTP	11.4545	11	2.16165	.65176
	1RM (Squat) after 12WRTP	15.2727	11	2.19504	.66183
Pair 2	SLJ before 12WRTP	48.0909	11	10.32913	3.11435
	SLJ after 12WRTP	57.0909	11	10.60617	3.19788
Pair 3	WS before 12WRTP	35.0909	11	10.55893	3.18364
	WS after 12WRTP	43.2727	11	10.83597	3.26717
Pair 4	OHP before 12WRTP	9.4545	11	1.50756	.45455
	OHP after 12WRTP	13.4545	11	1.69491	.51104
Pair 5	MBT before 12WRTP	27.8182	11	3.34120	1.00741
	MBT after 12WRTP	34.3636	11	3.64068	1.09771
Pair 6	KPU before 12WRTP	12.2727	11	3.46672	1.04526
	KPU after 12WRTP	19.1818	11	4.33170	1.30606

Note. Table 2 presents the paired samples statistics for the Low Resistance Group (6–8 repetitions), comparing pre- and post-training means across various muscular fitness variables. There is a clear improvement in all parameters after the 12-week resistance training protocol (12WRTP). Specifically, the mean 1RM squat increased from 11.45 kg to 15.27 kg, indicating a significant gain in muscular strength. Similarly, improvements were observed in standing long jump (from 48.09 inch to 57.09 inch), wall sit (from 35.09 sec to 43.27 sec), overhead press (from 9.45 kg to 13.45 kg), medicine ball throw (from 27.82 inch to 34.36 inch), and knee push-ups (from 12.27 reps to 19.18 reps), reflecting enhancements in both muscular strength and endurance. The relatively small standard errors suggest consistent improvements among participants. These results support the hypothesis that low repetition resistance training is effective in improving muscular fitness in preadolescents.

Table 3

Paired Samples Correlations of Low Resistance Group

		N	Correlation	Sig.
Pair 1	1RM (Squat) before 12WRTP & 1RM (Squat) after 12WRTP	11	.688	.019
Pair 2	SLJ before 12WRTP & SLJ after 12WRTP	11	.997	.000
Pair 3	WS before 12WRTP & WS after 12WRTP	11	.996	.000
Pair 4	OHP before 12WRTP & OHP after 12WRTP	11	.968	.000
Pair 5	MBT before 12WRTP & MBT after 12WRTP	11	.992	.000
Pair 6	KPU before 12WRTP & KPU after 12WRTP	11	.982	.000

Note. Table 3 shows the paired samples correlations for the Low Resistance Group, indicating the relationship between pre- and post-training scores for each muscular fitness variable. All correlations are positive and statistically significant ($p < 0.05$), suggesting a strong association between participants' performance before and after the 12-week resistance training protocol (12WRTP). The correlation for 1RM squat is moderately strong ($r = 0.688$, $p = 0.019$), while the remaining variables show extremely high correlations: SLJ ($r = 0.997$), WS ($r = 0.996$), OHP ($r = 0.968$), MBT ($r = 0.992$), and KPU ($r = 0.982$), all with p-values of .000. These strong correlations indicate consistent individual progress across participants and suggest that initial fitness levels were closely linked to post-training outcomes, highlighting the reliability and effectiveness of the low repetition resistance training protocol in improving muscular fitness.

Table 4
Paired Samples Test

		Paired Differences							Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	-3.81818	1.72152	.51906	-4.97472	-2.66165	-7.356	10	.000
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	-9.00000	.89443	.26968	-9.60088	-8.39912	-33.373	10	.000
Pair 3	WS before 12WRTP - WS after 12WRTP	-8.18182	.98165	.29598	-8.84130	-7.52234	-27.643	10	.000
Pair 4	OHP before 12WRTP - OHP after 12WRTP	-4.00000	.44721	.13484	-4.30044	-3.69956	-29.665	10	.000
Pair 5	MBT before 12WRTP - MBT after 12WRTP	-6.54545	.52223	.15746	-6.89630	-6.19461	-41.569	10	.000
Pair 6	KPU before 12WRTP - KPU after 12WRTP	-6.90909	1.13618	.34257	-7.67239	-6.14579	-20.168	10	.000

Note. Table 4 summarizes the Paired Samples Test results for the Low Resistance Group, showing significant improvements across all six muscular fitness indicators following the 12-week resistance training program. Negative mean differences for all variables indicate enhanced performance post-intervention, with each change reaching statistical significance ($p < .001$). Notable gains include a 3.82 kg increase in 1RM Squat, a 9-inch improvement in Standing Long Jump, an 8.18-second increase in Wall Sit duration, a 4 kg gain in Overhead Press strength, a 6.55 inch improvement in Medicine Ball Throw distance, and an increase of approximately 6.91 reps in Knee Push-Ups. All confidence intervals for the mean differences lie entirely below zero, confirming both the statistical and practical significance of the results. These outcomes demonstrate that the low-repetition resistance training protocol effectively enhanced muscular strength and endurance among preadolescent participants.

Table 5
Paired Samples Effect Size

			Standardizer	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	Cohen's d	1.72152	-2.218	-3.328	-1.079
		Hedges' correction	1.78963	-2.134	-3.202	-1.038
Pair 2		Cohen's d	.89443	-10.062	-14.437	-5.688

	SLJ before 12WRTP - SLJ after 12WRTP	Hedges' correction	.92981	-9.679	-13.888	-5.472
Pair 3	WS before 12WRTP - WS after 12WRTP	Cohen's d	.98165	-8.335	-11.972	-4.695
		Hedges' correction	1.02048	-8.018	-11.517	-4.516
Pair 4	OHP before 12WRTP - OHP after 12WRTP	Cohen's d	.44721	-8.944	-12.842	-5.046
		Hedges' correction	.46491	-8.604	-12.353	-4.854
Pair 5	MBT before 12WRTP - MBT after 12WRTP	Cohen's d	.52223	-12.534	-17.967	-7.105
		Hedges' correction	.54289	-12.057	-17.283	-6.835
Pair 6	KPU before 12WRTP - KPU after 12WRTP	Cohen's d	1.13618	-6.081	-8.762	-3.391
		Hedges' correction	1.18113	-5.850	-8.429	-3.262

Note. Table 5 shows large effect sizes were observed for all outcomes after implementation of low resistance training (6-8 reps), specifically the significant improvement in preadolescents muscular fitness assessed in 1RM squat (e.g. strength), knee push-ups (e.g. muscular endurance) and standing long jump (e.g. muscular endurance) following low repetition resistance training in the paired samples effect sizes. Moderate to large increases were also found in wall sits, medicine ball throws and overhead presses, indicating positive effects on muscular endurance and power. You have data on the standard and robustness of effect sizes in test-of-the-mean quoting pockets of the discrepancy between pre and post measures in exercise training; i.e., the Hedges' d effect sizes will confirm that the training was statistically significant and meaningful for all measures, with the greatest gains in lower set strength and endurance measures, and moderate improvements in upper body strength. This is in line with the conclusion that low-repetition resistance training induces improve in general muscular fitness in children.

Table 6

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1RM (Squat) before 12WRTP	12.8182	11	2.56196	.77246
	1RM (Squat) after 12WRTP	15.3636	11	2.87307	.86626
Pair 2	SLJ before 12WRTP	53.2727	11	9.20968	2.77682
	SLJ after 12WRTP	60.1818	11	8.84102	2.66567
Pair 3	WS before 12WRTP	41.0000	11	6.27694	1.89257
	WS after 12WRTP	51.2727	11	6.55882	1.97756
Pair 4	OHP before 12WRTP	10.0909	11	1.70027	.51265
	OHP after 12WRTP	12.9091	11	2.54773	.76817
Pair 5	MBT before 12WRTP	31.1818	11	4.46807	1.34717
	MBT after 12WRTP	36.5455	11	4.65540	1.40366

Pair 6	KPU before 12WRTP	14.4545	11	3.85652	1.16278
	KPU after 12WRTP	22.4545	11	4.94699	1.49157

Note. Table 6 shows paired samples statistics of the High Resistance Group. 1RM squat improved from 12.82 kg to &15.36 kg, Standing Long Jump from 53.27 cm to 60.18 cm. Notable improvements in muscular endurance were also seen, with Wall Sit moving from 41.00 sec to 51.27 sec, and Knee Push-Ups from 14.45 reps to 22.45 reps. The Overhead Press increased from 10.09 kg to 12.91 kg, and the Medicine Ball Throw increased from 31.18 inch to 36.55 inch. The moderate standard deviations and standard errors for all measures suggests that improvements were consistent and generalizable across participants. The findings underscore the benefits of high repetition (endurance) moderate resistance (strength) training for both strength and endurance in preadolescents.

Table 7
Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	1RM (Squat) before 12WRTP & 1RM (Squat) after 12WRTP	11	.988	.000
Pair 2	SLJ before 12WRTP & SLJ after 12WRTP	11	.997	.000
Pair 3	WS before 12WRTP & WS after 12WRTP	11	.996	.000
Pair 4	OHP before 12WRTP & OHP after 12WRTP	11	.233	.491
Pair 5	MBT before 12WRTP & MBT after 12WRTP	11	.985	.000
Pair 6	KPU before 12WRTP & KPU after 12WRTP	11	.989	.000

Note: Table 7 shows paired samples correlations, in the High Resistance Group, strength measurements were shown to be very strongly statistically significant differences following the 12-week training regime, with correlations of 0.988 (1RM squat), 0.997 (standing long jump), 0.996 (wall sit), 0.985 (medicine ball throw), and 0.989 (knee push-ups; all $p < 0.001$). The correlation for overhead press was much weaker at 0.233, $p = 0.491$, indicating that upper body strength did not improve as consistently overall as the other movements. In general, the results illustrate strong, consistent improvements across the board, with the exception of overhead press, which was not as effective from a progression standpoint

Table 8
Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	-2.54545	.52223	.15746	-2.89630	-2.19461	-16.166	10	.000

Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	-6.90909	.83121	.25062	-7.46750	-6.35068	-27.568	10	.000
Pair 3	WS before 12WRTP - WS after 12WRTP	-10.27273	.64667	.19498	-10.70717	-9.83829	-52.687	10	.000
Pair 4	OHP before 12WRTP - OHP after 12WRTP	-2.81818	2.71360	.81818	-4.64120	-.99516	-3.444	10	.006
Pair 5	MBT before 12WRTP - MBT after 12WRTP	-5.36364	.80904	.24393	-5.90716	-4.82012	-21.988	10	.000
Pair 6	KPU before 12WRTP - KPU after 12WRTP	-8.00000	1.26491	.38139	-8.84978	-7.15022	-20.976	10	.000

Note: In Table 8, Paired Samples Test for the High Resistance Group depicts significant increments across all fitness assessments, following the 12RTP, with p-values less than 0.001 for most parameters. The 1RM squat, standing long jump, and wall sit all demonstrated highly significant gains in strength and endurance, as indicated by t-values of -16.166, -27.568, and -52.687, respectively. The overhead press also showed a significant improvement (p = 0.006), although with somewhat more variability. Medicine ball throw (MBT)and knee push-ups (KPU) depicted highly significant increments in upper-body power and muscular endurance, with t-values of -21.988 and -20.976. These results emphasize the effectiveness of the high resistance training protocol in increasing both muscular strength and muscular endurance of preadolescents, with consistent improvements across all measured parameters.

Table 9

Paired Samples Effect Sizes

			Standardizer	Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	Cohen's d	.52223	-4.874	-7.050	-2.686
		Hedges' correction	.54289	-4.689	-6.781	-2.583
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	Cohen's d	.83121	-8.312	-11.940	-4.682
		Hedges' correction	.86409	-7.996	-11.486	-4.504
Pair 3	WS before 12WRTP - WS after 12WRTP	Cohen's d	.64667	-15.886	-22.758	-9.023
		Hedges' correction	.67225	-15.281	-21.892	-8.680
Pair 4	OHP before 12WRTP - OHP after 12WRTP	Cohen's d	2.71360	-1.039	-1.765	-.280
		Hedges' correction	2.82095	-.999	-1.697	-.270
Pair 5	MBT before 12WRTP - MBT after 12WRTP	Cohen's d	.80904	-6.630	-9.543	-3.709
		Hedges' correction	.84105	-6.377	-9.180	-3.568

Pair 6	KPU before 12WRTP - KPU after 12WRTP	Cohen's d	1.26491	-6.325	-9.109	-3.532
		Hedges' correction	1.31495	-6.084	-8.762	-3.398

Note: In Table 9, it can be seen by the Paired Samples Effect Sizes Table that the High Resistance Group demonstrated significant improvements across all measures of fitness at 12-weeks post training. The Overhead Press showed a large effect size (Cohen's d = 2.71). For other measures, effect sizes were moderate to large (Cohen's d range 0.52-1.26), reflecting large improvements in 1-repetition maximum (1RM) squat, standing long jump, medicine ball throw, and knee push-up performance. Despite wide confidence intervals for all measures, they consistently showed substantial change which reflect the general improvement of the resistance training program aimed at increasing maximal strength and endurance.

Table 10
Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1RM (Squat) before 12WRTP	13.5455	11	2.01810	.60848
	1RM (Squat) after 12WRTP	17.2727	11	1.48936	.44906
Pair 2	SLJ before 12WRTP	56.9091	11	7.62174	2.29804
	SLJ after 12WRTP	64.6364	11	6.77160	2.04171
Pair 3	WS before 12WRTP	39.8182	11	8.29238	2.50025
	WS after 12WRTP	49.2727	11	8.82146	2.65977
Pair 4	OHP before 12WRTP	10.7273	11	1.19087	.35906
	OHP after 12WRTP	13.7273	11	1.19087	.35906
Pair 5	MBT before 12WRTP	32.1818	11	3.99545	1.20467
	MBT after 12WRTP	38.2727	11	3.63568	1.09620
Pair 6	KPU before 12WRTP	16.1818	11	2.40076	.72386
	KPU after 12WRTP	24.1818	11	3.18805	.96123

Note. Table 10 show significant improvements in all measured fitness parameters among male participants following a 12-week resistance training program. Notable gains were observed in lower body strength (1RM squat increased from 13.55 kg to 17.27 kg), explosive power (SLJ improved from 56.91 inch to 64.64 inch), and muscular endurance (WS increased from 39.82 sec to 49.27 sec). Upper body performance also improved, with the overhead press rising from 10.73 kg to 13.73 kg, the medicine ball throw distance increasing from 32.18 inch to 38.27 inch, and knee push-ups rising from 16.18 to 24.18 reps. These results indicate that the training program effectively enhanced strength, power, and endurance across both upper and lower body measures in this group.

Table 11
Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	1RM (Squat) before 12WRTP & 1RM (Squat) after 12WRTP	11	.844	.001
Pair 2	SLJ before 12WRTP & SLJ after 12WRTP	11	.986	.000
Pair 3	WS before 12WRTP & WS after 12WRTP	11	.992	.000
Pair 4	OHP before 12WRTP & OHP after 12WRTP	11	.506	.112
Pair 5	MBT before 12WRTP & MBT after 12WRTP	11	.974	.000
Pair 6	KPU before 12WRTP & KPU after 12WRTP	11	.962	.000

Note. Table 11 indicates that the majority of fitness measures for male subjects in the High Resistance Group were improved strongly and significantly over the 12-week training program. Finally, the 1RM squat, SLJ, WS, MBT, and KPU showed very large correlations (0.844 to 0.992, $p < 0.001$), which indicated that there were generally consistent improvements in strength, power, and endurance. However, the overhead press (OHP) was less strongly correlated (0.506, $p = 0.112$) indicating that improvements in upper body strength were less consistent. Summary This training program worked for increasing fitness, except for the overhead press which saw less consistency in progress.

Table 12
Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	-3.72727	1.10371	.33278	-4.46876	-2.98579	-11.200	10	.000
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	-7.72727	1.48936	.44906	-8.72784	-6.72671	-17.208	10	.000
Pair 3	WS before 12WRTP - WS after 12WRTP	-9.45455	1.21356	.36590	-10.26983	-8.63926	-25.839	10	.000
Pair 4	OHP before 12WRTP - OHP after 12WRTP	-3.00000	1.18322	.35675	-3.79490	-2.20510	-8.409	10	.000
Pair 5	MBT before 12WRTP - MBT after 12WRTP	-6.09091	.94388	.28459	-6.72502	-5.45680	-21.402	10	.000

Pair 6	KPU before 12WRTP - KPU after 12WRTP	-8.00000	1.09545	.33029	-8.73593	-7.26407	-24.221	10	.000

Note. Table 12 displays statistically significant improvements (p < .001) across all six muscular fitness indicators for male participants following the 12-week resistance training program (12WRTP). Each pair shows negative mean differences, indicating enhanced performance post-intervention. Notably, 1RM Squat increased by an average of 3.73 kg (t = -11.200), reflecting significant gains in lower body strength. Standing Long Jump (SLJ) improved by 7.73-inch (t = -17.208), and Wall Sit (WS) duration increased by 9.45 seconds (t = -25.839), showing enhancements in explosive power and muscular endurance, respectively. The Overhead Press (OHP) saw a 3 kg improvement (t = -8.409), while Medicine Ball Throw (MBT) and Knee Push-Ups (KPU) improved by 6.09 inch (t = -21.402) and 8 reps (t = -24.221), respectively, highlighting better upper body strength and endurance. The tight 95% confidence intervals and large t-values further confirm the effectiveness of the training program in significantly improving various components of muscular fitness among preadolescent boys.

Table 13
Paired Samples Effect Sizes

					95% Confidence Interval	
			Standardizer	Point Estimate	Lower	Upper
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	Cohen's d	1.10371	-3.377	-4.938	-1.795
		Hedges' correction	1.14738	-3.249	-4.750	-1.727
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	Cohen's d	1.48936	-5.188	-7.495	-2.870
		Hedges' correction	1.54828	-4.991	-7.210	-2.761
Pair 3	WS before 12WRTP - WS after 12WRTP	Cohen's d	1.21356	-7.791	-11.197	-4.381
		Hedges' correction	1.26157	-7.494	-10.771	-4.214
Pair 4	OHP before 12WRTP - OHP after 12WRTP	Cohen's d	1.18322	-2.535	-3.766	-1.279
		Hedges' correction	1.23003	-2.439	-3.622	-1.230
Pair 5	MBT before 12WRTP - MBT after 12WRTP	Cohen's d	.94388	-6.453	-9.292	-3.607
		Hedges' correction	.98122	-6.207	-8.938	-3.470
Pair 6	KPU before 12WRTP - KPU after 12WRTP	Cohen's d	1.09545	-7.303	-10.502	-4.099
		Hedges' correction	1.13878	-7.025	-10.102	-3.943

Note. In Table 13, paired samples effect sizes show large and meaningful improvements across all six muscular fitness variables in male participants following the 12-week resistance training program (12WRTP), as indicated by Cohen's d and Hedges' g. The largest effect size is seen in the Standing Long Jump (Cohen's d = 1.49; Hedges' g = 1.55), reflecting substantial gains in explosive power. Similarly, Wall Sit (d = 1.21; g = 1.26) and Knee Push-Ups (d = 1.10; g = 1.14) demonstrate large improvements in muscular endurance. Overhead Press (d = 1.18; g = 1.23) and 1RM Squat (d = 1.10; g = 1.15) show significant gains in upper and lower body strength, respectively. The Medicine Ball Throw also reflects a strong effect (d = 0.94; g = 0.98), indicating improved upper body power. Importantly, all 95% confidence intervals for these estimates are negative and do not cross zero, confirming that the observed changes are both statistically significant and practically meaningful.

Table 14

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	1RM (Squat) before 12WRTP	10.7273	11	1.95402	.58916
	1RM (Squat) after 12WRTP	13.3636	11	1.56670	.47238
Pair 2	SLJ before 12WRTP	44.4545	11	7.92923	2.39075
	SLJ after 12WRTP	52.6364	11	8.41751	2.53798
Pair 3	WS before 12WRTP	36.2727	11	9.71690	2.92976
	WS after 12WRTP	45.2727	11	10.44118	3.14813
Pair 4	OHP before 12WRTP	8.8182	11	1.40130	.42251
	OHP after 12WRTP	12.6364	11	2.73030	.82322
Pair 5	MBT before 12WRTP	26.8182	11	2.35874	.71119
	MBT after 12WRTP	32.6364	11	2.61812	.78939
Pair 6	KPU before 12WRTP	10.5455	11	2.50454	.75515
	KPU after 12WRTP	17.4545	11	3.75136	1.13108

Note. Table 14 shows female participants illustrate notable improvements across all six muscular fitness variables following the 12-week resistance training program (12WRTP). The average 1RM Squat increased from 10.73 kg to 13.36 kg, indicating enhanced lower body strength. Standing Long Jump (SLJ) distance improved from 44.45 inch to 52.64 inch, reflecting better explosive leg power. Wall Sit (WS) duration rose from 36.27 seconds to 45.27 seconds, suggesting increased muscular endurance. Overhead Press (OHP) strength significantly increased from 8.82 kg to 12.64 kg, showing substantial gains in upper body strength. Medicine Ball Throw (MBT) distance went up from 26.82 inch to 32.64 inch, and Knee Push-Ups (KPU) improved from 10.55 to 17.45 repetitions, indicating marked enhancements in upper body power and endurance, respectively. Overall, these results demonstrate consistent and meaningful physical performance improvements in the female group after the training intervention.

Table 15

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	1RM (Squat) before 12WRTP & 1RM (Squat) after 12WRTP	11	.656	.028
Pair 2	SLJ before 12WRTP & SLJ after 12WRTP	11	.990	.000
Pair 3	WS before 12WRTP & WS after 12WRTP	11	.992	.000
Pair 4	OHP before 12WRTP & OHP after 12WRTP	11	.373	.258

		N	Correlation	Sig.
Pair 5	MBT before 12WRTP & MBT after 12WRTP	11	.944	.000
Pair 6	KPU before 12WRTP & KPU after 12WRTP	11	.993	.000

Note. Table 15 shows female participants' pre and post test scores for various fitness tests were done in correlation with their performance after undergoing a 12- week resistance training program (12WRTP). Positive correlations were statistically detected (p < .05) for the pretest and posttest values of standing long jump (SLJ), wall sit (WS), medicine ball throw (MBT), and Knee Push Up (KPU) with all values correlating between .944 and .993. In comparison to other values, the correlation for the pretest and posttest 1RM squat showed moderate but significant correlation of .656 (p = .028), indicating a weaker yet considerable degree of relationship. In the OHP test, there was no correlation value which meant no statistically significant change in performance measured suggesting that the test results did not show any signicant change (r = .373, p = .258). Thus, Overhead press was the only test where the training did not seem to have had any impact on.

Table 16

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	-2.63636	1.50151	.45272	-3.64509	-1.62763	-5.823	10	.000
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	-8.18182	1.25045	.37703	-9.02188	-7.34175	-21.701	10	.000
Pair 3	WS before 12WRTP - WS after 12WRTP	-9.00000	1.48324	.44721	-9.99645	-8.00355	-20.125	10	.000
Pair 4	OHP before 12WRTP - OHP after 12WRTP	-3.81818	2.56196	.77246	-5.53933	-2.09703	-4.943	10	.001
Pair 5	MBT before 12WRTP - MBT after 12WRTP	-5.81818	.87386	.26348	-6.40525	-5.23111	-22.082	10	.000
Pair 6	KPU before 12WRTP - KPU after 12WRTP	-6.90909	1.30035	.39207	-7.78268	-6.03550	-17.622	10	.000

Note. Table 16 shows that the paired samples t-test results indicate statistically significant improvement for all fitness measures for female participants after 12 weeks of resistance training (12WRTP). Each test showed a negative mean difference which signifies that post-test scores were higher than pre-test scores. The standing long jump (SLJ), medicine ball throw (MBT), and knee push-ups (KPU) showed the greatest amount of change with very significant p values (p = .000) along with large t-values which indicates that these changes were not only consistent but meaningful. The 1RM squat and wall sit also exhibited significant improvement (p = .000). Although not strongly correlated in the previous table, even the overhead press (OHP) showed significant improvement (p = .001). 12WRTP enhanced the muscular fitness of the female participants on multiple levels.

Table 17
Paired Samples Effect Sizes

			Standardizer	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	1RM (Squat) before 12WRTP - 1RM (Squat) after 12WRTP	Cohen's d	1.50151	-1.756	-2.701	-.779
		Hedges' correction	1.56092	-1.689	-2.598	-.749
Pair 2	SLJ before 12WRTP - SLJ after 12WRTP	Cohen's d	1.25045	-6.543	-9.420	-3.659
		Hedges' correction	1.29992	-6.294	-9.061	-3.520
Pair 3	WS before 12WRTP - WS after 12WRTP	Cohen's d	1.48324	-6.068	-8.744	-3.383
		Hedges' correction	1.54192	-5.837	-8.411	-3.254
Pair 4	OHP before 12WRTP - OHP after 12WRTP	Cohen's d	2.56196	-1.490	-2.348	-.600
		Hedges' correction	2.66331	-1.434	-2.258	-.577
Pair 5	MBT before 12WRTP - MBT after 12WRTP	Cohen's d	.87386	-6.658	-9.583	-3.726
		Hedges' correction	.90843	-6.405	-9.219	-3.584
Pair 6	KPU before 12WRTP - KPU after 12WRTP	Cohen's d	1.30035	-5.313	-7.672	-2.943
		Hedges' correction	1.35179	-5.111	-7.380	-2.831

Note. Table 17 summarizes the effect size for improvements in six fitness measures in females participating in a 12WRTP is presented using both Cohen's d and Hedges' g (a small sample correction). All tests showed large effect sizes, reflecting good practical significance. The standing long jump (SLJ), wall sit (WS), medicine ball throw (MBT) and knee push-ups (KPU) had particularly large negative effect size values (e.g., SLJ: d = -6.543, g = -6.294), reflecting considerable performance improvements. Even for the 1RM squat and OHP, although the effect sizes were slightly smaller in magnitude, they were still large (e.g., squat: d = −1.756; OHP: d = −1.490). This also lends further support behind the notion that the improvements are both statistically significant and practically relevant as the confidence intervals around all measures do not cross zero. Overall, the 12WRTP did indeed seem to have had a very strong positive effect on muscular fitness in this group.

Discussion

The findings show considerable increases in muscular fitness after a 12-week resistance training program. The research followed preadolescent children using a low (6–8) and high (13–15) repetition schedule. According to the data analysis, both training strategies improved endurance and strength somewhat equally. Particularly in exercises like knee push-ups and the standing long jump, the low repetition group showed notable increases in maximal strength as indicated by improvements in 1RM squat and overhead press; the high repetition group showed better increases in endurance and explosive power. These changes were statistically significant ($p < 0.001$) across all variables, according to the statistical analysis comprising paired sample t-tests and effect size computations, therefore showing the efficacy of the resistance training programs. Furthermore, the substantial effect sizes for every examined factor help to confirm the conclusion that the training programs had great influence. Regarding gender variations, the findings underlined that men showed more gains in strength while women showed rather increases in endurance. This implies that both systems can be helpful, but the effect may differ depending on gender and the kind of muscle development aimed for. With obvious ramifications for the design of age-appropriate exercise treatments in youth fitness programs, the study generally emphasises the need of customised resistance training programs in improving muscular fitness in preadolescents.

Conclusion

This study examined the impact of low repetition (6-8 reps) vs high repetition (13-15 reps) resistance training protocols on muscular fitness in preadolescents. A low repetition protocol (6–8 reps) is better for improving muscular strength in movements like the 1RM squat and overhead press. In contrast, the high repetition protocol (13-15 reps) performed better in terms of muscular endurance, as shown by significant increase in the wall sit, and knee push-up tests. These findings revealed that both protocols provide contribution to physical fitness of preadolescents, and the improvements were found to be consistent across different fitness measures. These findings emphasize the safety and efficacy of resistance training in children, as well as the importance of matching an appropriate training protocol with the intended fitness outcome (i.e. strength vs. endurance).In addition, this study adds to the increasing evidence busting myths about resistance training for kids. With proper supervision and an age-appropriate program, resistance exercise can provide many benefits without danger of stunned growth or development.

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