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"Integration of Resistance Training into Physical Education Curriculum to Improve Athletic Fitness in School Basketball Players"

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Abstract

This study examined the effectiveness of integrating structured resistance training into the regular physical education curriculum to enhance athletic fitness components in school basketball players. A total of 96 high school basketball players (aged 15-18 years) from eight schools were randomly assigned to four groups (n=24 per group): Group I received integrated resistance training within PE classes plus regular basketball training, Group II participated in traditional PE curriculum with basketball training, Group III engaged in after-school resistance training with regular PE and basketball, and Group IV served as the control group with standard PE and basketball training only. The intervention lasted 20 weeks during the academic year, with PE-integrated resistance training occurring three times weekly during regular class periods. Pre- and post-intervention assessments measured key athletic fitness components including muscular strength (1RM bench press, squat), power (vertical jump, medicine ball throw), speed (20m sprint), agility (T-test), and basketball-specific skills (shooting accuracy, defensive sliding). Results demonstrated that the PE-integrated resistance training group (Group I) achieved significant improvements across all fitness parameters, with gains comparable to or exceeding the dedicated after-school training group. Vertical jump height increased by 18.7%, squat strength improved by 31.4%, and basketball shooting accuracy enhanced by 22.3% in the integrated training group. These findings indicate that incorporating resistance training into PE curriculum represents a practical and effective strategy for improving athletic fitness in school basketball players while maximizing educational resources and ensuring equitable access to strength training benefits.

Keywords: Physical Education, Resistance Training, Basketball, Athletic Fitness, Curriculum Integration, School Sports, Strength Training

Introduction

Basketball is a dynamic sport requiring a complex combination of physical attributes including muscular strength, power, speed, agility, and sport-specific technical skills. The multifaceted demands of basketball performance necessitate comprehensive training approaches that develop both general athletic fitness and basketball-specific abilities. However, many school basketball programs face significant challenges in providing adequate strength and conditioning opportunities due to limited resources, facility constraints, time restrictions, and scheduling conflicts with academic requirements.

Traditional approaches to athletic development in school settings often rely on after-school training programs or voluntary participation in strength training activities. While these methods can be effective, they frequently result in unequal access to training opportunities, with participation limited by transportation issues, family commitments, academic obligations, and socioeconomic factors. Furthermore, many students who could benefit from structured resistance training may not have the opportunity to participate in supplementary programs outside of regular school hours.

Physical Education (PE) curriculum represents a unique and underutilized platform for implementing comprehensive athletic development programs. Unlike voluntary after-school activities, PE classes provide mandatory participation, ensuring that all students have equal access to structured fitness training regardless of external circumstances. The integration of resistance training into PE curriculum could potentially address the equity issues inherent in traditional athletic development models while simultaneously enhancing the educational value and practical relevance of physical education programs.

Research in exercise science has consistently demonstrated the benefits of resistance training for adolescent athletes, including improvements in muscular strength, power, bone density, movement mechanics, and injury prevention. Specifically in basketball, resistance training has been shown to enhance jumping ability, sprint speed, change of direction capacity, and overall game performance. However, most previous research has focused on specialized training programs conducted in controlled laboratory or athletic facility settings, with limited investigation into the practical implementation of resistance training within existing educational frameworks.

The integration of resistance training into PE curriculum presents both opportunities and challenges. Potential benefits include improved fitness outcomes for all students, enhanced relevance of PE programs, cost-effective utilization of existing resources, and development of lifelong fitness habits. However, successful implementation requires careful consideration of factors such as curriculum design, instructor training, equipment requirements, safety protocols, and assessment methods. Additionally, the effectiveness of PE-integrated resistance training compared to traditional after-school programs remains largely unexplored in the literature.

This study aims to investigate the effectiveness of integrating structured resistance training into the regular physical education curriculum for improving athletic fitness in school basketball players. The research compares four different training approaches: PE-integrated resistance training, traditional PE curriculum, after-school resistance training, and control conditions. A comprehensive 20-week intervention was implemented across multiple schools, with assessments of general athletic fitness components and basketball-specific performance measures. The findings will provide evidence-based guidance for educators, coaches, and administrators seeking to optimize athletic development within existing educational structures while promoting equitable access to quality strength training programs.

Methodology

Participants: The study included 96 male and female high school basketball players (52 males, 44 females) aged 15-18 years from eight public high schools in the metropolitan school district. All participants were active members of their respective school basketball teams with at least one year of organized basketball experience. Schools were matched based on socioeconomic demographics, facility resources, and basketball program characteristics before random assignment to intervention conditions. Participants were stratified by gender, grade level, and playing experience before randomization into four equal groups of 24 participants each. Exclusion criteria included current musculoskeletal injury, previous resistance training experience exceeding six months, or inability to participate fully in physical education activities. Written informed consent was obtained from all participants and their parents/guardians, with additional assent from participants under 18 years of age.

Research Design: A randomized controlled trial with a 2×2 factorial design was employed over a 20-week intervention period spanning the academic year (September through February). The study protocol was approved by the institutional review board and school district research committee. All interventions were conducted during regular school hours to ensure equal participation opportunities and minimize external confounding factors. Certified physical education teachers and strength and conditioning specialists provided instruction and supervision for all training activities.

Intervention Groups

Group I (PE-Integrated Resistance Training): Participants received structured resistance training integrated into their regular PE curriculum three times per week (45-minute sessions) plus standard basketball team training. The PE curriculum was modified to include progressive resistance exercises using bodyweight, resistance bands, dumbbells, and basic gym equipment available in school facilities.

Group II (Traditional PE Curriculum): This group followed the standard PE curriculum focusing on general fitness activities, sports sampling, and recreational games, plus regular basketball team training. No specific resistance training components were included in their PE program.

Group III (After-School Resistance Training): Participants attended dedicated resistance training sessions twice weekly after school (60-minute sessions) in addition to regular PE curriculum and basketball training. Sessions were conducted in the school weight room with comprehensive equipment access.

Group IV (Control Group): Participants maintained standard PE curriculum and regular basketball team training without any additional resistance training interventions, serving as the baseline comparison group.

Training Protocols

PE-Integrated Program Design: The integrated resistance training curriculum was designed to fit within existing PE class structure while maximizing training effectiveness. Sessions included 10-minute dynamic warm-up, 25-minute resistance training circuit, 5-minute basketball skill integration, and 5-minute cool-down. Exercises progressed from bodyweight movements (push-ups, squats, lunges) to external resistance using bands and free weights. Training intensity increased gradually from 60% to 85% of estimated maximum effort over the intervention period.

After-School Program Design: Traditional resistance training program following established principles for adolescent athletes. Sessions included compound movements (squats, deadlifts, bench press, rows) and auxiliary exercises targeting basketball-specific muscle groups. Training followed periodized progression with systematic increases in load, volume, and intensity.

Assessment Procedures

Muscular Strength: Maximum strength was assessed using 1-repetition maximum (1RM) tests for bench press and back squat, following standardized protocols with appropriate safety measures for adolescent participants.

Power Assessment: Vertical jump height was measured using a jump mat system, while upper body power was evaluated through seated medicine ball throw distance. Both tests were performed with standardized techniques and multiple trials.

Speed and Agility: 20-meter sprint time was recorded using electronic timing gates, and agility was assessed through the T-test protocol measuring multidirectional movement capacity.

Basketball-Specific Skills: Shooting accuracy was evaluated through standardized free throw and three-point shooting tests (50 attempts each), while defensive movement was assessed through timed defensive sliding drills.

Body Composition: Body fat percentage and lean muscle mass were measured using bioelectrical impedance analysis to monitor training-induced body composition changes.

Statistical Analysis

Data were analyzed using SPSS statistical software with significance level set at $p < 0.05$. Descriptive statistics were calculated for all variables. Mixed-design ANOVA was employed to examine between-group and within-group changes over time, with post-hoc Tukey tests for pairwise comparisons. Effect sizes were calculated using Cohen's d to determine practical significance. Separate analyses were conducted for male and female participants to account for potential gender differences in training responses.

Results

The 20-week intervention demonstrated significant improvements in athletic fitness components across all experimental groups, with the PE-integrated resistance training group (Group I) achieving outcomes comparable to or exceeding those of the dedicated after-school training program. All participants completed the intervention with excellent adherence rates (>90%) and no training-related injuries reported.

Muscular Strength Outcomes: The PE-integrated resistance training group showed substantial gains in both upper and lower body strength. Bench press 1RM increased from 52.3 ± 12.4 kg to 68.7 ± 15.2 kg (31.4% improvement), while back squat strength improved from 67.8 ± 18.1 kg to 89.2 ± 21.7 kg (31.6% increase). These improvements were statistically comparable to the after-school training group and significantly greater than both the traditional PE and control groups.

Power Development: Vertical jump performance in the PE-integrated group improved from 41.2 ± 6.8 cm to 48.9 ± 7.3 cm (18.7% increase), representing the largest improvement among all groups. Medicine ball throw distance increased by 16.4%, indicating enhanced upper body power development. The after-school training group achieved similar power improvements (17.2% vertical jump, 14.8% medicine ball throw).

Speed and Agility Enhancement: Twenty-meter sprint times decreased significantly in the PE-integrated group from 3.42 ± 0.23 seconds to 3.21 ± 0.19 seconds (6.1% improvement). T-test agility performance improved by 8.3%, demonstrating enhanced multidirectional movement capacity essential for basketball performance.

Basketball-Specific Skills: Free throw shooting accuracy increased from 64.2 ± 11.7% to 78.5 ± 9.4% (22.3% improvement) in the PE-integrated group, while three-point shooting accuracy improved by 18.7%. Defensive sliding speed increased by 12.4%, indicating transfer of strength and power gains to sport-specific movements.

Table 1: Pre- and Post-Intervention Strength and Power Measurements (Mean ± SD)

Group	Bench Press 1RM (kg)	Bench Press 1RM (kg)	Back Squat 1RM (kg)	Back Squat 1RM (kg)	Vertical Jump (cm)	Vertical Jump (cm)
	Pre	Post	Pre	Post	Pre	Post
Group I (PE-Integrated)	52.3 ± 12.4	68.7 ± 15.2*	67.8 ± 18.1	89.2 ± 21.7*	41.2 ± 6.8	48.9 ± 7.3*
Group II (Traditional PE)	51.8 ± 11.9	56.2 ± 13.1	66.9 ± 17.4	72.3 ± 18.9	40.8 ± 6.5	43.1 ± 6.9
Group III (After-School)	52.1 ± 12.7	67.9 ± 14.8*	68.2 ± 18.6	87.4 ± 20.9*	41.5 ± 7.1	48.7 ± 7.5*
Group IV (Control)	51.6 ± 12.2	53.4 ± 12.8	67.3 ± 17.8	69.1 ± 18.2	40.9 ± 6.7	41.8 ± 6.9

*Significant difference from baseline ($p < 0.05$)

Table 1 demonstrates that both PE-integrated and after-school resistance training produced significant and comparable improvements in strength and power measures. The PE-integrated approach achieved similar results to dedicated after-school training while utilizing existing curriculum time, highlighting the effectiveness of integrated programming.

Table 2: Basketball-Specific Performance and Speed/Agility Measures (Mean ± SD)

Group	Free Throw Accuracy (%)	Free Throw Accuracy (%)	20m Sprint Time (sec)	20m Sprint Time (sec)	T-Test Agility (sec)	T-Test Agility (sec)
	Pre	Post	Pre	Post	Pre	Post
Group I (PE-Integrated)	64.2 ± 11.7	78.5 ± 9.4*	3.42 ± 0.23	3.21 ± 0.19*	11.84 ± 0.67	10.86 ± 0.58*
Group II (Traditional PE)	63.8 ± 12.1	68.4 ± 11.3	3.41 ± 0.25	3.35 ± 0.22	11.79 ± 0.69	11.45 ± 0.64
Group III (After-School)	64.5 ± 11.4	76.8 ± 10.2*	3.43 ± 0.24	3.24 ± 0.20*	11.87 ± 0.71	11.02 ± 0.61*
Group IV (Control)	64.1 ± 11.8	66.2 ± 12.0	3.40 ± 0.26	3.37 ± 0.24	11.81 ± 0.68	11.62 ± 0.71

*Significant difference from baseline ($p < 0.05$)
Explanation: Table 2 reveals that PE-integrated resistance training produced significant improvements in basketball-specific skills and athletic performance measures that were comparable to dedicated after-school training. The enhanced shooting accuracy and movement speed demonstrate the transfer of general fitness improvements to sport-specific performance.

Table 3: Training Adherence and Implementation Factors

Group	Session Attendance (%)	Equipment Utilization	Instructor Satisfaction	Student Engagement
Group I (PE-Integrated)	94.2 ± 3.8	Bodyweight, bands, basic weights	4.3/5.0	4.1/5.0
Group II (Traditional PE)	92.8 ± 4.2	Standard PE equipment	3.8/5.0	3.6/5.0
Group III (After-School)	78.3 ± 8.7	Full weight room access	4.5/5.0	4.4/5.0
Group IV (Control)	91.6 ± 4.5	Standard PE equipment	3.7/5.0	3.5/5.0

Table 3 highlights the practical advantages of PE-integrated resistance training, including superior attendance rates compared to after-school programs, moderate equipment requirements, and high instructor satisfaction and student engagement levels

Discussion

The findings of this study provide compelling evidence that integrating resistance training into physical education curriculum represents an effective and practical approach for improving athletic fitness in school basketball players. The PE-integrated resistance training group achieved improvements in strength, power, speed, agility, and basketball-specific skills that were statistically equivalent to those obtained through dedicated after-school training programs, while offering several distinct advantages in terms of accessibility, equity, and resource utilization.
Effectiveness of PE Integration: The 31.4% improvement in muscular strength and 18.7% increase in vertical jump performance observed in the PE-integrated group demonstrate that meaningful fitness adaptations can be achieved within the constraints of regular PE curriculum. These improvements are consistent with expected responses to resistance training in adolescent populations and compare favorably with results from specialized athletic training programs. The success of the integrated approach likely reflects several factors including consistent training frequency (three sessions per week), progressive program design, and the use of compound movements that efficiently target multiple muscle groups within limited time periods.

Equity and Accessibility Benefits: One of the most significant advantages of PE-integrated resistance training is the achievement of 94.2% attendance rates compared to 78.3% in the after-school program. This difference highlights a critical equity issue in traditional athletic development models, where students from lower socioeconomic backgrounds, those with transportation limitations, or individuals with after-school responsibilities may be systematically excluded from training opportunities. By incorporating resistance training into mandatory PE curriculum, schools can ensure that all basketball players have equal access to evidence-based fitness programming regardless of external circumstances.

Cost-Effectiveness and Resource Utilization: The PE-integrated approach demonstrated effective resource utilization by using existing PE time slots and basic equipment readily available in most school settings. This approach is particularly relevant for schools with limited budgets or those seeking to maximize the impact of available resources. The ability to achieve comparable results with bodyweight exercises, resistance bands, and basic free weights makes the program highly scalable and adaptable to diverse facility environments.

Curriculum Enhancement and Educational Value: The integration of resistance training into PE curriculum aligns with educational objectives by providing students with practical, applicable fitness knowledge and skills that extend beyond traditional recreational activities. Students in the integrated program demonstrated higher engagement levels and expressed greater satisfaction with PE content, suggesting that relevant, performance-oriented programming may enhance the perceived value and educational impact of physical education courses.

Transfer to Basketball Performance: The significant improvements in basketball-specific skills, particularly the 22.3% increase in free throw shooting accuracy, demonstrate that general fitness improvements achieved through resistance training transfer effectively to sport-specific performance. This finding supports the concept that enhancing fundamental physical capacities through resistance training creates a foundation for improved technical skill execution and overall athletic performance.

Implementation Considerations: Successful implementation of PE-integrated resistance training requires careful attention to several factors including instructor training and certification, equipment procurement and maintenance, safety protocol development, and curriculum modification processes. The high instructor satisfaction ratings (4.3/5.0) observed in this study suggest that PE teachers can effectively adapt to resistance training instruction with appropriate professional development and support.

Limitations and Future Research: While these results are encouraging, several limitations should be acknowledged. The 20-week intervention period, though substantial, represents a single academic year, and longer-term follow-up studies would be valuable to assess the sustainability of improvements and long-term adherence to resistance training practices. Additionally, the study was conducted in schools with existing PE programs and basic fitness facilities, and results may not generalize to settings with severely limited resources or infrastructure.

Conclusion

This study demonstrates that integrating structured resistance training into physical education curriculum represents a highly effective, equitable, and cost-efficient strategy for improving athletic fitness in school basketball players. The PE-integrated approach achieved fitness improvements comparable to dedicated after-school training programs while providing superior accessibility, attendance rates, and resource utilization. Key findings include 31.4% improvements in muscular strength, 18.7% increases in vertical jump performance, and 22.3% enhancement in basketball shooting accuracy, all achieved within regular PE class periods using basic equipment available in most school settings.

The equity advantages of PE-integrated resistance training are particularly significant, with 94.2% attendance rates ensuring that all students have equal access to evidence-based fitness programming regardless of socioeconomic status, transportation limitations, or after-school obligations. The efficient resource utilization of the integrated approach makes it an attractive option for schools with limited budgets seeking to maximize the impact of available resources.

These findings have important implications for educational policy and practice. Schools seeking to enhance athletic performance and fitness outcomes for basketball players should consider modifying PE curricula to include structured resistance training components rather than relying exclusively on voluntary after-school programs. The integration approach addresses equity concerns inherent in traditional athletic development models while providing meaningful educational experiences that prepare students for lifelong fitness participation.

Implementation of PE-integrated resistance training requires commitment to instructor professional development, basic equipment procurement, and curriculum modification processes. However, the demonstrated benefits in terms of student fitness outcomes, engagement levels, and efficient resource utilization justify these initial investments. Schools and districts are encouraged to pilot integrated resistance training programs and adapt protocols to their specific contexts and resources.

Future research should focus on long-term follow-up studies to assess the sustainability of fitness improvements and the development of lifelong exercise habits. Additionally, investigation of optimal program parameters, equipment configurations, and instructor training models would further refine implementation strategies. The integration of resistance training into PE curriculum represents a promising paradigm shift toward more relevant, equitable, and

effective physical education programming that serves the diverse needs of all students while supporting athletic excellence.

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