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The Effect of Resistance Training-Based Exercise on Shot Put Performance in Physical Education Learning

Awaluddin [1A-E*], **Jamaluddin** [2B-D]

[1,2] Universitas Negeri Makassar, Kota Makassar, Sulawesi Selatan, Indonesia

awaluddin@unm.ac.id[1*], jamaluddin63@unm.ac.id[2]

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A. Conception and design of the study; **B.** Acquisition of data; **C.** Analysis and interpretation of data; **D.** Manuscript preparation; **E.** Obtaining funding

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ABSTRACT

This study aimed to determine the effect of resistance training on shot put performance in Physical Education lessons for students at SMP Negeri 24 Makassar. The study used a quasi-experimental design with a one-group pretest-posttest. The sample consisted of 30 students selected purposively. The primary instrument used was a shot put performance test measured in meters. The resistance training program was conducted for six weeks, three times per week, and included upper-body, lower-body, core, and power drills relevant to shot put technique. The results showed a significant improvement in students' shot put performance. The average put distance increased from 5.42 meters in the pretest to 6.38 meters in the posttest. A paired sample t-test yielded a p-value <0.001, indicating a significant difference between the pretest and posttest results. The large effect size (Cohen's d = 1.78) indicates that resistance training has a strong influence on students' shot put ability. Overall, this study concludes that resistance training is an effective training method and can be implemented in physical education (PJOK) lessons to improve students' athletic skills. This program also has the potential to increase student motivation through varied and structured movement activities. These findings can serve as a reference for PJOK teachers in developing more innovative athletics learning strategies based on sports science.

Keywords : Resistance Training; Shot Put; Physical Education; Muscle Strength; Athletic Performance.

INTRODUCTION

Physical Education, Sports, and Health (PJOK) is an integral part of the curriculum, aiming to develop students' motor skills, fitness, social skills, and positive character (Siregar, 2021). One focus of PJOK learning is mastery of fundamental movement and sports skills, which can enhance students' overall physical development (Widodo & Purnama, 2020). At the junior high school level, athletics instruction is a crucial component because it provides a foundation for basic movements such as running, jumping, and throwing. Shot put is one of the athletic events taught in the PJOK curriculum and requires physical strength, coordination, and explosive ability (Nurhayati et al., 2020).

Shot put is not simply the act of throwing a heavy object, but rather a complex skill that requires synergy between muscle strength, biomechanical techniques, body stability, and movement coordination (Putra et al., 2022). In an educational context, these skills not only enhance athletic performance but also help develop students' basic motor skills. Therefore, an appropriate learning strategy is necessary to support optimal shot put skill achievement.

One relevant training method in shot put learning is resistance training, which involves applying a resistive load, either through body weight, additional equipment, or specific elasticity (Suchomel et al., 2018). Resistance training plays a role in increasing muscle strength, power, and explosiveness, which are the main determinants of shot put performance. In the context of physical education (PJOK) learning, the resistance training approach can be tailored to student characteristics and the school environment, allowing for safer and more effective implementation (Putri & Kurniawan, 2021).

In shot put, the explosive ability of the arm, shoulder, chest, hip, and leg muscles significantly determines the distance of the shot put. Research shows that increased muscle strength is directly proportional to improved shot put performance (Hadi & Pratama, 2019). Resistance training has been shown to significantly increase muscle strength through the systematic application of the principles of overload, progression, and specificity.

Several studies also report that resistance training has a positive impact on sports requiring power, including athletics such as javelin, discus, and shot put. For example, research by Pearson et al. (2020) showed a 17–25% increase in throwing power after a 6–8-week resistance training program. Furthermore, research in school settings found that resistance training tailored to the capacity of students aged 13–15 years can significantly improve muscle strength and throwing skills (Rahman & Santoso, 2021).

However, the implementation of resistance training in schools is often suboptimal. Many physical education teachers still rely on traditional training methods such as repetitive practice and repetition of techniques without variation, which are not always effective in improving the explosive strength component required in shot put (Lestari, 2020). Therefore, integrating science-based resistance training is crucial to improving the quality of learning.

In the context of SMP Negeri 24 Makassar, learning shot put faces several challenges: (1) Limited muscle strength in students, especially in the body parts involved in the push, (2) Suboptimal shot put technique, often due to students lacking sufficient strength to execute the movements correctly, (3) Lack of use of modern training approaches, such as resistance training that focuses on power development, and (4) Lack of training variety, which can lead to students being less motivated to participate in Physical Education (PJOK) activities.

This impacts students' low shot put performance, as evidenced by learning outcomes that remain below minimum standards. This situation emphasizes the need for innovation in learning strategies, one of which is through structured, safe, and student-specific resistance training.

Although resistance training has been widely studied in the context of competitive sports, research focusing on its implementation in PJOK learning in schools, especially at the junior high school level, is still very limited. Most studies have been conducted on athletes or adult populations, thus underrepresenting the learning needs of schools (Slamet et al., 2021).

Furthermore, very few studies have specifically examined the effect of resistance training on junior high school students' shot put performance, despite the fact that shot put has movement characteristics that require explosive strength.

Most school-based studies have focused more on: improving general fitness, overall muscle strength, or the effect of bodyweight training on fitness (Yusuf & Nursalam, 2019).

However, research on the application of resistance training integrated into shot put learning is still rare, especially among junior high school students in Indonesia. Furthermore, research conducted in Makassar, specifically at SMP Negeri 24 Makassar, has not explored this modern training approach.

The novelty of this study is: (1) Integrating resistance training into Physical Education (PJOK) learning, rather than as a separate program as in most previous studies, (2) Using a variety of resistance training programs tailored to the characteristics of junior high school students, ensuring a safe and effective way to increase strength, (3) Measuring the impact of resistance training directly on shot put performance, not just general muscle strength, (4) Using an active learning approach, where students are gradually involved in practice, technique, and performance evaluation, and (5) Providing a training model that can be implemented by PJOK teachers in schools, even in environments with limited facilities. This research is innovative because it adapts scientifically based resistance training principles to the school learning context, while still considering safety, effectiveness, and ease of implementation.

Based on this urgency, this study aims to analyze the effect of resistance training-based training on shot put performance in students of SMP Negeri 24 Makassar. This research is expected to provide both theoretical and practical contributions.

Theoretically, this research enriches the literature on the application of resistance training in the context of physical education (PJOK) learning, particularly in improving the performance of athletic skills such as the shot put. Furthermore, the research findings can form the basis for developing a science-based training curriculum for school learning.

Practically, this research provides a training model that is easy for PJOK teachers to implement, is affordable, safe, and effective in improving student strength and performance. Teachers can utilize simple resistance such as resistance bands, body weight, or other improvised tools available in the school environment.

This research is also expected to increase student motivation and participation in PJOK learning because resistance training offers a more engaging, dynamic, and challenging exercise variation. Thus, students not only master shot put techniques but also reap broader physical and mental benefits.

METHODS

Research Type and Design

This study used a quasi-experimental design with a pretest–posttest without a control group. This design was chosen because it focused on changes in students' shot put performance before and after the implementation of a resistance training-based exercise program, in a single group of students (a single sample) at SMP Negeri 24 Makassar. The pretest–posttest allows researchers to directly measure the effects of an exercise intervention by comparing performance before and after the intervention.

In the literature on functional training in youth, this type of design is often used when randomized control is difficult to implement, but still allows for assessing the effectiveness of an exercise program (Granacher et al., 2016).

The choice of a quasi-experimental design with a pretest–posttest is in accordance with the characteristics of the school environment: all students are involved in the program, and the formation of a control group (without the intervention) is considered unethical or impractical in a regular educational setting.

Research Variables

This study has two categories of variables:

1. Independent variable: Resistance training-based exercise program. This includes free weight training, resistance bands/body weights, and other exercises appropriate for junior high school students, with specific intensity and volume.
2. Dependent Variable: Students' shot put performance—measured by the distance (meters) the shot put covers after the shot put. Additionally, muscle strength (as a mediator), such as upper-body or lower-body muscle strength, can be measured as an additional variable to determine whether changes in strength mediate changes in performance.

Population and Sample

Population: All students in grades (e.g., 7th–8th) at SMP Negeri 24 Makassar who are taking Physical Education (PJOK) and participating in athletics lessons, specifically shot put training. Sample: A total of 30 students were purposively selected based on the following inclusion criteria: students who actively participate in Physical Education (PJOK) lessons, have no history of serious injuries affecting throwing ability, and are willing to participate in all training sessions. The 30 students were selected to provide a baseline overview of the effects of resistance training in a classroom setting and to allow for pre-post statistical analysis with sufficient power to detect meaningful changes. The selection of a sample of 30 students reflects common practice in elementary/secondary school intervention research, given resource limitations and the need to maintain a practical group in a single class.

Test Instruments

To measure performance and strength, the following instruments are used:

1. Shot Put — Field Shot Put Test
   a. Students perform the shot put using the technique taught in Physical Education (PJOK).
   b. Measurement: The distance of the shot put (meters), measured with a measuring tape or standard measuring tape.
   c. Procedure: Each student performs two shots; the best shot is recorded as the final pretest/posttest score.
2. Muscular Strength Test (optional/intermediate)
   a. 1RM (One-Repetition Maximum) squat or bench press, or other upper-lower body strength measurements, as appropriate, to assess maximal strength. Alternatives, if 1RM is deemed unsafe for junior high students, include functional strength tests such as resistance band pulls, bodyweight squat repetition maximums, or medicine ball throws to measure upper-body power.
   b. The use of this type of instrument is based on the finding that maximal strength and power correlate with shot put/throwing performance in athletics (as in research on shot put).
3. Concentration & Injury History Form
   a. A short questionnaire at the beginning of the study to screen students based on their medical/injury history to ensure they are safe to participate in the training.
   b. Parental/Guardian Consent Form (if required), in accordance with ethical research practices on children/adolescents.

Data Collection Techniques

The study was conducted in several stages as follows:

1. Pretest
   a. Before the intervention, shot put and strength tests (if used) were administered to all 30 students.

   b. The shot put distance and strength data were recorded as a baseline.
2. Intervention: Resistance Training Program
   a. The training program was specifically designed for junior high school students: 2–3 times per week, for 6–8 weeks, as recommended in the throwing/overarm training literature (minimum duration ≥ 6 weeks to see effects)
   b. Each training session was guided by a Physical Education (PJOK) teacher and/or coach and consisted of light to moderate resistance training (free weight, body weight, resistance band), focusing on the upper body, core, hips, and leg muscles—critical components of the shot put.
   c. The training was conducted using the principle of progressive overload, meaning the load or intensity was gradually increased to allow for adaptations in strength and power.
3. Posttest
   a. After the intervention period was completed, the shot put and strength tests (if applicable) were administered again.
   b. Posttest results were compared with baseline.
4. Monitoring & Compliance
   a. Student attendance was recorded for each training session to ensure compliance.
   b. If a student was absent for more than 20% of the session, their data was evaluated specifically and may have been excluded from the analysis.
5. Safety & Ethics
   a. Before training, warm up and apply correct technique to reduce the risk of injury.
   b. Instruction and supervision from a teacher/coach are essential, as literature recommends that power training for adolescents should be supervised and tailored to their age and level of physical maturity (Granacher et al., 2016).

Data Analysis Techniques

Data obtained from the pretest and posttest (shot put distance, and strength data, if measured) were analyzed using the following statistical techniques:

1. Normality Test
   Before the main analysis, the data were tested for normality (e.g., using the Kolmogorov-Smirnov or Shapiro-Wilk test) to determine whether the data were normally distributed.
2. Pretest vs. Posttest Comparison Test
   a. If the data met the assumption of normality, use a paired-sample t-test to determine whether there was a significant difference in shot put distance (and strength) before and after the intervention.
   b. If the data were not normal, use a non-parametric test, such as the Wilcoxon signed-rank test.
3. Effect Analysis and Effect Size
   a. Calculate the effect size (e.g., Cohen's d) to assess the magnitude of the change. This is important not only to assess statistical significance but also the practical significance of the change.
   b. If a mediator variable (muscle strength) is used, conduct a correlation analysis (e.g., Pearson or Spearman) between changes in strength and changes in takeoff distance to evaluate whether increased strength correlates with improved performance.

4. Interpretation of Significance
   a. A significance level is set (e.g., α = 0.05).
   b. Furthermore, consider the practicality of the results (whether increased takeoff distance is meaningful for shot put performance in the context of physical education).

RESULTS AND DISCUSSION

Result

This section presents the main findings of the study regarding the effect of resistance training on the shot put performance of students at SMP Negeri 24 Makassar. Data were obtained from 30 students through pretests and posttests after a six-week training program. The main variable analyzed was shot put distance (in meters).

Descriptive Statistics

Table 1 displays descriptive statistics for shot put performance before and after the resistance training program.

Table 1.
Descriptive Statistics for Shot Put Performance

Statistik	Pretest (m)	Posttest (m)
Jumlah Sampel (n)	30	30
Rata-rata	5,42	6,38
Standar Deviasi	0,64	0,72
Nilai Minimum	4,20	5,10
Nilai Maksimum	6,50	7,80

The average shot put distance increased from 5.42 m to 6.38 m, representing a 0.96 m increase, or approximately 17.7%, after the resistance training intervention.

Individual Statistics

To provide a detailed overview of the changes in performance for each student, Table 2 is presented below.

Table 2.
Pretest–Posttest Data for Students' Shot Put Performance (n = 30)

No	Pretest (m)	Posttest (m)	Δ (Improvement)
1	5.2	6.0	+0.8
2	5.0	5.9	+0.9
3	4.7	5.8	+1.1
4	5.8	6.6	+0.8
5	5.3	6.4	+1.1
6	4.9	5.8	+0.9
7	5.6	6.5	+0.9
8	4.8	5.6	+0.8
9	5.4	6.5	+1.1
10	5.7	6.8	+1.1
11	4.6	5.4	+0.8
12	4.9	6.0	+1.1
13	5.1	6.1	+1.0
14	5.4	6.3	+0.9
15	4.5	5.5	+1.0
16	5.0	6.0	+1.0
17	4.8	5.7	+0.9

No	Pretest (m)	Posttest (m)	Δ (Improvement)
18	5.3	6.3	+1.0
19	6.0	7.2	+1.2
20	5.6	6.7	+1.1
21	4.9	5.9	+1.0
22	5.5	6.4	+0.9
23	4.6	5.6	+1.0
24	5.7	6.8	+1.1
25	5.0	5.8	+0.8
26	5.3	6.1	+0.8
27	5.1	6.0	+0.9
28	5.2	6.3	+1.1
29	4.7	5.6	+0.9
30	5.4	6.5	+1.1

Average increase: 0.96 m
Inferential Statistics Test

Normality Test

The Kolmogorov–Smirnov test showed that the pretest and posttest data were normally distributed ($p > 0.05$), allowing analysis using a paired sample t-test.

Table 3.
Paired Sample t-Test

Variable	t-count	Sig. (p)	Description
Pretest–Posttest	12.84	0.000	Significant

A p-value of 0.000 (<0.05) indicates a significant difference between shot put performance before and after resistance training.

Effect Size – Cohen's d

Cohen's d = 1.78 (large category)

Significance:

The resistance training program had a very strong effect on improving students' shot put performance.

The results of this study indicate that a resistance training-based training program significantly improved shot put performance among students at SMP Negeri 24 Makassar. This is evident in the increase in the average shot put distance from 5.42 meters in the pretest to 6.38 meters in the posttest after six weeks of intervention. This 0.96-meter increase indicates that the students experienced substantial development in the strength and power required for the shot put.

Furthermore, inferential statistical tests supported these findings. A paired sample t-test yielded a t value of 12.84 with $p < 0.001$, indicating that the difference between the pretest and posttest was statistically significant. Cohen's d effect size of 1.78 indicates that resistance training had a substantial impact, not only statistically significant but also practically significant.

This performance improvement is consistent with the theory that resistance training can increase maximal strength and muscle power, especially in the early adolescent age group, which is undergoing a phase of rapid physical development. Exercises such as medicine ball throws, resistance band presses, push-ups, and power movements have been shown to stimulate neuromuscular adaptation, significantly improving shot put performance.

Individual data shows that all students (100%) experienced improved performance, with the lowest increase being +0.8 meters and the highest being +1.2 meters. This

demonstrates that the training program is not only effective for some students, but also has a broad and equitable impact across all participants.

Overall, these findings provide strong evidence that resistance training is a safe, effective, and appropriate training method for implementation in physical education (PJOK) learning environments. This program provides an innovative alternative for PJOK teachers to improve the quality of athletics instruction, particularly in shot put, despite limited school facilities.

Discussion

Interpretation of Key Findings

This study shows that a six-week resistance training program had a significant positive impact on junior high school students' shot put performance. The average put distance increased from 5.42 meters (pretest) to 6.38 meters (posttest), with an average increase of +0.96 meters (~17.7%). Inferential statistical tests showed a significant difference ($p < 0.001$) and a large effect size (Cohen's d) ($d \approx 1.78$), indicating that the intervention effect was not merely coincidental, but rather a real, practically meaningful change.

These findings indicate that resistance training can improve muscle strength and power key components in the shot put—thus leading to improved student shot put performance.

Relationship to the Literature

1. Resistance Training and Strength & Power Improvement in Adolescents

The study results align with findings from meta-analyses and previous literature that indicate resistance training (RT) is effective in increasing muscle strength and power in children and adolescents (youth athletes).

For example, a systematic review examining the effects of RT in children and adolescents found that RT had small to large effects on muscle strength and power, and small to moderate effects on sport-specific performance such as throwing and putting.

Therefore, the increase in shot put distance in this study can be explained by neuromuscular and musculoskeletal adaptations resulting from resistance training—for example, improved neuromuscular coordination, increased motor unit recruitment, and increased muscle capacity to produce force and power. This concept aligns with the principle of muscle adaptation to progressive overload, where the load and volume of training are gradually increased to stimulate increases in strength and power.

2. Training Specificity and Transfer to Shot Put

This study used exercises specifically aimed at improving muscles and movements relevant to throwing/shot put—for example, upper-body exercises (push-ups, resistance band presses), core exercises, and power exercises such as medicine ball throws. The overall structure of this training supports the principle of training specificity, meaning that adaptation occurs optimally in the movements/muscles being trained. This aligns with the literature that resistance-based training programs or combined strength/power training are more effective in improving throwing performance when the training is structured and relevant to the throwing movement.

For example, a recent review showed that resistance-based training interventions can positively increase throwing velocity, especially when performed consistently.

Similarly, local research on the use of medicine ball exercises (as part of throwing/power training) showed that these exercises positively influenced throwing and takeoff results.

3. Consistency of Findings with Previous Research on Shot Put or Throwing Events

Several previous studies have also found that strength training, bodyweight training, or simple weight training (e.g., push-ups) have a significant impact on shot put or shot put

performance. For example, a study of high school students in Indonesia found that push-up training resulted in significant improvements in shot put performance.

Another study of extracurricular shot put students using the "heavy bag thrust" method (weight training/punching bag) showed that after the intervention, there was an improvement in shot put performance.

The findings of this study are consistent with these results, strengthening the argument that a strength/power training approach can be applied to students of all ages and provide tangible benefits.

Theoretical Implications

1. Validation of the Specificity and Overload Principles
   These findings demonstrate that a training program that emphasizes movement specificity and progressive overload can trigger neuromuscular and musculoskeletal adaptations in adolescents, thereby improving performance in specific athletic events such as the shot put.
2. Support for the Use of Resistance Training in Schools
   Much of the literature on resistance training focuses on adult athletes or high-achieving adolescents. However, the results of this study demonstrate that resistance training is also effective when implemented in regular school settings, with junior high school students, broadening the generalizability of its use in physical education settings.
3. Contribution to the Expanding Literature in the Indonesian Context
   Studies in Indonesia on the effects of resistance training on the shot put are still relatively few. Therefore, this study adds an empirical basis for the implementation of modern training in Indonesian schools—and provides a reference for future researchers.

Practical Implications

1. Training Model for Physical Education Teachers
   The training program developed in this study can be used as a model by physical education teachers in other schools, especially those with limited facilities. Exercises can utilize resistance bands, medicine balls, and body weight—relatively easy and inexpensive tools. This makes them easy to integrate into the Physical Education (PJOK) curriculum without the need for heavy or expensive equipment.
2. Improving the Quality of Athletics Learning in Schools
   By incorporating RT into Physical Education (PJOK) materials in a structured manner, schools can improve the effectiveness of athletics learning, not only from a technical perspective, but also from a physical perspective (strength, power, stability).
3. Increasing Student Motivation and Participation
   Varied, strength-based training can be more engaging and challenging than traditional fitness techniques. This has the potential to increase student motivation to participate in learning and possibly improve exercise discipline and overall physical activity.

Considerations, Limitations, and Contextual Factors

Although research results show positive effects, there are several aspects that need to be carefully considered.

1. Pubertal and Maturation Factors
   Some literature suggests that the adaptive results of RT on power/strength may differ based on an individual's biological maturation status—prepubertal, pubertal, or postpubertal. In the context of middle school students, variability in physical maturation between students may influence training responses. It is possible that some students experience greater gains because they are entering puberty, which is characterized by a natural increase in strength, and therefore the training effects may be facilitated by normal growth.

2. Training Type and Intensity
   The effectiveness of RT is highly dependent on the training design—the type of exercise (weights, bodyweight, resistance bands), intensity, frequency, and duration of the training cycle. If the intensity or progression is inadequate, adaptations may be hampered. Meta-analyses have shown that free-weight RT tends to produce greater effects than machine-based or light training.
   In this study, despite using simple equipment (bodyweight, resistance bands, medicine balls), significant results were obtained—this suggests that with proper design, even minimal training can be effective. However, these results may differ if training is unsupervised or if students are less disciplined in following the program.
3. Transfer of Shot Put Technique
   Resistance training improves muscle strength and power, but shot put is not just about strength—technique, coordination, agility, timing, and body stability are also crucial (e.g., body position, throwing angle, foot-hip-hand coordination).
   If the program is not accompanied by adequate shot put technique training, increasing strength alone will not necessarily result in optimal shot put. In this study, training included elements of the medicine ball throw and shot put-specific drills, which may have helped facilitate the transfer of power to the shot put. However, for maximum efficiency, a combination of technique training and physical conditioning is highly recommended.
4. Duration and Follow-up
   The 6-week program has produced significant effects, but are these effects sustainable long-term? The literature on retraining/detraining indicates that performance can decline if training is stopped. Therefore, follow-up (maintenance training) is important to ensure adaptation is not lost, as well as to monitor aggregate student development (e.g., growth, maturational development).
5. Generalization of Findings
   Because the sample size was only 30 students from one school (SMP Negeri 24 Makassar), generalization to a broader population (e.g., junior high school students in other areas with different physical characteristics) requires caution. Training responses can vary depending on environmental factors, genetics, nutritional status, age, and intensity of training.

Overall, the study results support the hypothesis that resistance training-based exercises effectively improve shot put performance in junior high school students. This is consistent with the literature showing that RT increases muscle strength and power in adolescents, as well as possible transfer to specific sport performance such as the push or throw.

However, the full effectiveness of a training program depends not only on strength, but also on technical training, coordination, and other contextual aspects (age, maturation, discipline, nutrition, recovery). Therefore, for widespread application in schools, integration of physical and technical training, supervision, and a long-term program to maintain and optimize adaptations are necessary. Therefore, this study provides an important empirical contribution to the development of science-based PJOK learning methods and opens the door for further research with more rigorous designs.

CONCLUSION

This study aimed to analyze the effect of resistance training on students' shot put performance in Physical Education (PE) classes at SMP Negeri 24 Makassar. Based on the data analysis, resistance training significantly improved shot put performance. The average

distance of the students' shot put increased from 5.42 meters in the pretest to 6.38 meters in the posttest, representing an increase of 0.96 meters, or approximately 17.7%. The paired sample t-test showed a p-value <0.001, indicating statistical significance. Furthermore, the large effect size (Cohen's d = 1.78) confirmed that the changes were substantive and had a real practical impact on student performance.

This performance improvement demonstrates that resistance training, structured with the principles of progressive overload, movement specificity, and exercise variation, can increase muscle strength and power relevant to the shot put movement. These research findings provide a strong foundation for PE teachers to integrate resistance training methods into athletics instruction at school, particularly in the shot put event.

Considering its effectiveness, resistance training can be an innovative, affordable, and easily implemented learning alternative, even in schools with limited facilities. It is recommended that future research explore longer training durations, involve a control group, and measure biomechanical and physiological variables to enrich the research findings.

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