Journal of Sport Praxis and Human Performance
ISSN (E): XXXX-XXXX ║ Volume 1 Issue 1, 2026 ║ P.19-27
https://cakra-edus.id/index.php/JSPHP
cakra.journal@gmail.com ║ 082348954778

The Effect of Acceleration Training on The Speed 60-Meters Short Distance Running

M. Nurul Aqsyah[1A-E*], **Sahabuddin**[2B-D], **Muslim**[3B-D]

[1,2,3] Universitas Negeri Makassar, Sulawesi Selatan, Indonesia

nurulaqsa99@gmail.com[1*], sahabuddin@unm.ac.id[2], muslim@unm.ac.id[3]

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

ARTICLE HISTORY
Reviewed: 2026/01/10
Accepted: 2026/02/15
Published: 2026/03/21

KEYWORDS
Training;
Acceleration;
Speed 60-Meters;
Short Distance;
Running.

ABSTRACT
This study aimed to examine the effect of acceleration training on 60-meter sprint speed among students of Madrasah Ibtidaiyah DDI Pulele. Sprint performance in elementary school students is strongly influenced by acceleration ability, lower-limb explosive power, running coordination, stride frequency, and sprint technique. Initial observations showed that students had difficulty performing effective acceleration during short-distance running, resulting in suboptimal sprint performance. This study used a quantitative experimental method with a pre-test and post-test control group design. The sample consisted of 20 male and female students divided into an acceleration training group and a control group, with 10 students in each group. Data were collected through observation and a 60-meter sprint test, then analyzed using descriptive statistics, normality testing, and paired-samples t-test at a significance level of 0.05. The results showed that the acceleration training group improved from a pre-test mean of 9.804 ± 0.542 seconds to a post-test mean of 8.473 ± 0.101 seconds, with a mean difference of 1.331 seconds. The paired-samples t-test showed a significant effect of acceleration training on sprint speed, with t = 8.361, df = 9, and p = 0.000 < 0.05. Meanwhile, the control group showed only a small improvement from 9.807 ± 0.473 seconds to 9.618 ± 0.463 seconds. These findings indicate that structured acceleration training effectively improves 60-meter sprint speed by enhancing neuromuscular coordination, explosive leg power, stride efficiency, and early-phase running mechanics. Therefore, acceleration training is recommended as an effective strategy in elementary school athletics learning.

Cites this Article : Aqsyah, M.N.; Sahabuddin, S.; Muslim, M. (2026). The Effect of Acceleration Training on The Speed 60-Meters Short Distance Running. **Journal of Sport Praxis and Human Performance**. 1(1), P.19-27

INTRODUCTION

Athletics is widely recognized as one of the oldest and most fundamental sports, encompassing natural human movement patterns such as walking, running, jumping, and throwing. The term athletics originates from the Greek words athlon or athlum, meaning contest or competition. Across different regions, athletics is referred to by various terms, including track and field in English-speaking countries, leichtathletik in Germany, and athletiek in the Netherlands. Despite these linguistic differences, athletics remains the foundation of physical education because it develops essential motor skills, physical fitness, and competitive abilities among children and adolescents.

Among the various athletics disciplines, sprinting has received considerable attention due to its reliance on explosive muscular performance and neuromuscular coordination. Sprint events require athletes to generate maximal speed within a short distance through efficient acceleration, optimal running mechanics, and effective finishing techniques. Although international competitions commonly feature 100 m, 200 m, and 400 m sprint events, the 60-meter sprint remains an appropriate performance assessment for elementary school students because it emphasizes the acceleration phase while minimizing the influence of speed endurance. Consequently, 60-meter sprint performance has become a practical indicator of children's speed development and athletic potential.

Sprint performance is determined by several interrelated factors, including reaction time, starting technique, stride frequency, stride length, lower-limb explosive power, muscular strength, and acceleration ability. Among these components, acceleration plays a decisive role during the initial phase of sprinting, where athletes rapidly increase velocity from a stationary position to near maximal speed. Failure to develop proper acceleration mechanics often results in reduced sprint performance regardless of an athlete's overall physical capacity. Therefore, acceleration training has become an important component of modern sprint conditioning because it enhances neuromuscular efficiency, force production, and movement coordination during the early stages of running.

However, observations conducted at Madrasah Ibtidaiyah DDI Pulele revealed that many students experienced difficulties in executing the acceleration phase effectively during 60-meter sprint activities. Most students demonstrated slow transitions from the starting position, insufficient forward body lean, limited stride power, and inadequate acceleration mechanics, leading to suboptimal sprint performance. These findings indicate that sprint instruction in elementary schools frequently emphasizes the completion of running tasks rather than systematically developing acceleration ability through structured training programs. As a result, students often fail to achieve their optimal running speed despite participating regularly in physical education classes.

Recent advances in sports science demonstrate that sprint performance is strongly influenced by acceleration-specific training interventions. Contemporary evidence indicates that acceleration training improves horizontal force production, lower-limb power output, sprint mechanics, neuromuscular coordination, and overall running efficiency. Various training approaches—including resisted sprinting, sled towing, hill sprinting, short-distance acceleration drills, plyometric exercises, and sprint technique training—have consistently produced significant improvements in short-distance sprint performance among youth athletes.

Previous studies have also highlighted that acceleration training enhances the rate of force development, which directly contributes to faster sprint starts and improved early-phase running velocity. Furthermore, neuromuscular adaptations resulting from repeated acceleration exercises increase motor unit recruitment and intermuscular coordination, enabling athletes to produce greater propulsive forces during ground contact. Such adaptations are particularly important for young learners because childhood represents a sensitive period for developing speed-related motor abilities.

Within physical education settings, structured sprint-based interventions have been shown to improve not only running speed but also students' confidence, movement competence, and participation during athletics lessons. Research published in reputable Scopus- and SINTA-indexed journals over the past decade consistently reports that well-designed speed training programs can significantly increase sprint performance while promoting long-term physical literacy among school-aged children. Nevertheless, the effectiveness of these interventions depends on training specificity, appropriate progression, and instructional quality.

Despite growing international evidence regarding sprint development, several important gaps remain. First, many existing studies focus primarily on adolescent athletes, elite sprinters, or sports academy participants, while relatively limited research investigates elementary school students in Islamic primary schools (Madrasah Ibtidaiyah). Consequently, evidence regarding age-appropriate acceleration training for younger learners remains insufficient.

Second, previous investigations have frequently examined plyometric training, resistance training, strength development, or multidimensional speed programs, whereas fewer studies specifically isolate acceleration training as the primary intervention affecting 60-meter sprint performance. This distinction is important because acceleration represents the most influential phase of short-distance sprinting.

Third, most published studies originate from high-performance sports environments with advanced training facilities. There remains limited empirical evidence concerning the implementation of simple, low-cost acceleration training programs that can be integrated into regular physical education lessons in Indonesian elementary schools. Therefore, practical recommendations suitable for school contexts are still lacking.

Finally, limited evidence exists regarding acceleration training among students in rural educational environments such as Madrasah Ibtidaiyah DDI Pulele. Differences in facilities, student characteristics, instructional approaches, and physical activity opportunities may influence training outcomes, making localized empirical investigations necessary. Addressing these gaps will contribute both theoretically and practically to physical education and youth athletics development.

Based on the identified problems and research gaps, this study aims to examine the effect of acceleration training on 60-meter sprint speed among students at Madrasah Ibtidaiyah DDI Pulele. Specifically, the study seeks to determine whether a structured acceleration training program significantly improves students' sprint performance compared with their initial performance.

The novelty of this research lies in several aspects. First, it investigates acceleration training as a focused intervention rather than combining multiple physical conditioning methods, thereby providing clearer evidence regarding its specific contribution to sprint speed improvement. Second, the study targets elementary school students enrolled in an Islamic educational institution, a population that has received relatively limited attention in previous sprint research. Third, the intervention is designed using practical and school-based acceleration drills that require minimal equipment, making the training easily applicable by physical education teachers in resource-limited environments. Finally, the findings are expected to enrich contemporary evidence concerning youth sprint development while providing scientifically grounded recommendations for improving athletics instruction in Indonesian primary education.

In conclusion, acceleration ability constitutes one of the most critical determinants of successful sprint performance because it directly influences the transition from the starting phase to maximal running speed. Given the observed deficiencies in students' acceleration techniques at Madrasah Ibtidaiyah DDI Pulele and the limited empirical evidence available for elementary school settings, investigating the effectiveness of structured acceleration training becomes both academically relevant and practically necessary. The findings of this study are expected to contribute to the development of evidence-based sprint training models that enhance students' physical performance and improve the quality of athletics learning in primary schools.

METHODS

This study employed a quantitative experimental approach to examine the effect of acceleration training on 60-meter sprint performance among students at Madrasah Ibtidaiyah DDI Pulele. Experimental research is widely recognized as the most appropriate method for determining causal relationships between training interventions and changes in physical performance because it enables researchers to control treatment conditions and objectively measure performance outcomes. Recent literature in sports science also recommends experimental designs for evaluating the effectiveness of speed-development programs in school-aged populations, particularly when investigating sprint-related physical capacities.

The study adopted a one-group pretest–posttest experimental design, in which participants completed a sprint performance assessment before and after participating in a structured acceleration training program. This design allows researchers to determine changes in sprint performance attributable to the intervention by comparing baseline and post-intervention measurements. Similar methodological approaches have been extensively applied in recent studies examining sprint acceleration, neuromuscular adaptations, and youth athletic performance.

The population consisted of students at Madrasah Ibtidaiyah DDI Pulele who participated in athletics learning activities. The research sample comprised 20 male and female students, selected using purposive sampling based on predetermined inclusion criteria, including active participation in physical education classes, good health status, regular attendance throughout the intervention period, and willingness to participate in the study. This sampling technique is considered appropriate for experimental studies involving school-based physical training because it ensures participant homogeneity and minimizes potential confounding variables.

The independent variable was the acceleration training program, while the dependent variable was 60-meter sprint speed. The acceleration training protocol consisted of progressive short-distance acceleration drills designed to improve running mechanics, stride frequency, lower-limb force production, and neuromuscular coordination. The intervention was implemented systematically during scheduled training sessions following established principles of exercise progression, specificity, and overload that have been recommended in contemporary sprint training research.

Data were collected using systematic observation and a 60-meter sprint performance test administered during both the pretest and posttest phases. Observation sheets were used to monitor participants' adherence to training procedures and movement execution, whereas sprint performance was measured using standardized athletics testing procedures to ensure reliability and consistency. Prior to data collection, all participants completed identical warm-up activities and performed the sprint test under comparable environmental conditions to minimize measurement bias.

The collected data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics. Assumptions of normality and homogeneity were examined before hypothesis testing. The effectiveness of the acceleration training program was evaluated using a paired-samples t-test with a significance level of $\alpha = 0.05$. Statistical analyses were conducted using IBM SPSS Statistics, and the findings were interpreted to determine whether acceleration training produced a statistically significant improvement in 60-meter sprint performance among students at Madrasah Ibtidaiyah DDI Pulele.

RESULTS AND DISCUSSION

Result

This study investigated the effect of an acceleration training program on 60-meter sprint performance among students at Madrasah Ibtidaiyah DDI Pulele. The empirical data consisted of pre-test and post-test sprint times obtained from both the experimental group (acceleration training) and the control group. Prior to hypothesis testing, all data were tabulated and analyzed using descriptive and inferential statistics. Descriptive analysis was conducted to summarize the characteristics of the data, including the mean, standard deviation, variance, minimum value, maximum value, range, and total score. Inferential analysis was subsequently performed to examine data normality and to test the proposed hypothesis.

Descriptive Statistical Analysis

The descriptive statistics for the 60-meter sprint performance of both groups are presented in Table 1.

Table 1.
Descriptive Statistics of 60-Meter Sprint Performance

Descriptive Statistics	Acceleration Training Group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
N	10	10	10	10
Mean	9.8040	8.4730	9.8070	9.6180
Standard Deviation	0.54234	0.10078	0.47324	0.46327
Variance	0.294	0.010	0.224	0.215
Range	1.75	0.35	1.25	1.23
Minimum	9.15	8.31	9.25	9.15
Maximum	10.90	8.66	10.50	10.38
Sum	98.04	84.73	98.07	96.18

The descriptive findings demonstrate substantial improvements in sprint performance following the acceleration training intervention. The experimental group ($n = 10$) recorded a pre-test mean sprint time of 9.8040 ± 0.54234 seconds, with scores ranging from 9.15 to 10.90 seconds. Following the intervention, the mean sprint time decreased to 8.4730 ± 0.10078 seconds, representing a considerable reduction in sprint completion time. Moreover, the standard deviation declined markedly from 0.54234 to 0.10078, indicating greater consistency in participants' sprint performance after the training program.

In contrast, the control group demonstrated only marginal improvement. The pre-test mean was 9.8070 ± 0.47324 seconds, while the post-test mean decreased slightly to 9.6180 ± 0.46327 seconds. The relatively small change suggests that routine physical education activities without structured acceleration training produced only limited improvements in sprint speed.

Overall, the descriptive analysis indicates that students who participated in the acceleration training program achieved substantially greater reductions in 60-meter sprint times than those in the control group, suggesting a positive effect of the intervention on sprint performance.

Normality Test

Before conducting hypothesis testing, the assumption of data normality was evaluated using both the Kolmogorov–Smirnov and Shapiro–Wilk tests. The results are presented in Table 2.

Table 2.

Results of the Normality Test

Variable	Kolmogorov–Smirnov		Shapiro–Wilk		α	Interpretation
	Statistic	Sig.	Statistic	Sig.		
Acceleration Training	0.193	0.200	0.932	0.469	0.05	Normal
Control Group	0.181	0.200	0.902	0.232	0.05	Normal

The normality test results indicate that all significance values exceeded the predetermined significance level ($p > 0.05$). For the acceleration training group, the Kolmogorov–Smirnov test produced $D = 0.193$, $p = 0.200$, while the Shapiro–Wilk test yielded $W = 0.932$, $p = 0.469$. Similarly, the control group demonstrated $D = 0.181$, $p = 0.200$ and $W = 0.902$, $p = 0.232$, respectively.

Since all probability values were greater than $\alpha = 0.05$, the data were considered normally distributed. Therefore, the assumptions required for parametric statistical analysis were satisfied, allowing the use of the paired-samples *t*-test for hypothesis testing.

Effect of Acceleration Training on 60-Meter Sprint Performance

To determine whether acceleration training significantly improved sprint performance, a paired-samples *t*-test was conducted by comparing pre-test and post-test scores within the experimental group.

Table 3.

Paired-Samples *t*-Test for the Experimental Group

Variable	Mean	Mean Difference	*t*	df	Sig. (2-tailed)	*t*-table
Post-test	8.4730	1.33100	8.361	9	0.000	1.833
Pre-test	9.8040					

The paired-samples *t*-test revealed a statistically significant improvement in sprint performance following the acceleration training program. The calculated t-value was 8.361, which exceeded the critical t-table value of 1.833 (*df* = 9). Furthermore, the obtained significance value ($p = 0.000$) was considerably lower than the established significance level ($\alpha = 0.05$).

These findings indicate that the null hypothesis (H_0) was rejected, whereas the alternative hypothesis (H_1) was accepted. Therefore, it can be concluded that acceleration training produced a statistically significant effect on 60-meter sprint speed among students at Madrasah Ibtidaiyah DDI Pulele.

The intervention resulted in a mean improvement of 1.331 seconds, representing a substantial reduction in sprint completion time between the pre-test and post-test measurements. This magnitude of improvement demonstrates that acceleration-focused exercises effectively enhanced students' ability to generate rapid force production during the initial sprint phase, improve running mechanics, and reach higher running velocities over the 60-meter distance.

Overall, the statistical findings consistently demonstrate that the acceleration training program was significantly more effective in improving short-distance sprint performance than conventional physical education activities, thereby supporting the effectiveness of acceleration-based training for developing speed among elementary school students.

Discussion

The findings of this study demonstrate that the implementation of an acceleration training program produced a statistically significant improvement in 60-meter sprint performance among students at Madrasah Ibtidaiyah DDI Pulele. This conclusion is supported by the paired-samples t-test results, which showed a calculated t-value of 8.361, exceeding the critical t-table value of 1.833, with a significance level of $p = 0.000$ (< 0.05). Furthermore, the experimental group exhibited a substantial reduction in sprint time from 9.804 ± 0.542 seconds during the pre-test to 8.473 ± 0.101 seconds in the post-test, representing an average improvement of 1.331 seconds. In contrast, the control group showed only a slight improvement, indicating that structured acceleration training was considerably more effective than conventional physical education activities. These findings reinforce contemporary evidence suggesting that sprint acceleration is one of the primary determinants of short-distance running performance, particularly during the first 10–30 meters where athletes generate the majority of horizontal propulsion. Recent studies have also emphasized that improvements in acceleration capacity contribute substantially to overall sprint performance in children and adolescents.

From an anatomical perspective, the effectiveness of acceleration training can be explained by the coordinated development of the musculoskeletal structures responsible for sprint locomotion. During the acceleration phase, efficient running requires synchronized movement among the femur, tibia, fibula, hip joints, ankle joints, and spinal column to maintain body alignment and generate forward momentum. Elementary school children are still undergoing rapid skeletal growth; therefore, training programs must be designed according to developmental principles to avoid excessive mechanical stress while stimulating functional adaptation. Appropriate acceleration exercises facilitate improvements in lower-limb alignment, postural stability, and mechanical efficiency without exceeding the physiological capacity of growing bones and connective tissues. Recent investigations involving young athletes further demonstrate that improvements in sprint performance are closely associated with maturation of lower-extremity structures and the development of efficient movement patterns rather than merely increases in muscular strength.

The physiological adaptations induced by acceleration training also provide a strong explanation for the significant improvements observed in this study. Sprinting over a distance of 60 meters relies predominantly on the adenosine triphosphate-phosphocreatine (ATP-PC) system, which provides immediate energy for high-intensity muscular contractions lasting less than ten seconds. Repeated acceleration drills stimulate the phosphagen energy system, increase neuromuscular efficiency, and improve the rate of force development, enabling athletes to produce explosive movements more rapidly. These adaptations also enhance motor unit recruitment, synchronization of fast-twitch muscle fibers, and neural transmission efficiency. Consequently, students become capable of generating greater propulsive force during the initial running steps, resulting in faster acceleration and reduced sprint time. Contemporary sports physiology consistently reports that acceleration-oriented sprint training improves explosive performance through neuromuscular rather than purely metabolic adaptations, particularly in children whose nervous systems remain highly responsive to motor learning.

Biomechanically, the improvement observed in this research reflects enhanced sprint mechanics during the acceleration phase. Effective acceleration requires athletes to adopt a forward body lean, maintain optimal trunk alignment, generate powerful arm swings, and apply horizontal force efficiently against the ground. Sprint velocity is primarily determined by the interaction between stride length and stride frequency, both of which are influenced by lower-limb force production and movement coordination. Following the acceleration training intervention, participants demonstrated shorter sprint times, suggesting improvements in their ability to orient ground reaction forces horizontally while maintaining efficient stride mechanics. Previous biomechanical investigations have shown that successful sprinters generate greater horizontal impulse during the initial acceleration phase, allowing them to achieve higher velocities in fewer steps. Similarly, individualized acceleration training enhances force orientation and mechanical effectiveness, thereby improving sprint performance even without substantial increases in muscle mass.

The activation of major lower-limb muscles also contributes substantially to the positive outcomes reported in this study. During sprint acceleration, the gluteus maximus serves as the primary hip extensor responsible for forward propulsion, while the quadriceps femoris stabilizes the knee during ground contact and facilitates force transmission. Simultaneously, the hamstring muscles contribute to hip extension and rapid leg recovery, whereas the gastrocnemius and soleus generate powerful plantarflexion to maximize push-off velocity. The core musculature functions to stabilize the trunk, ensuring efficient transfer of force between the upper and lower extremities. Repeated acceleration exercises stimulate these muscle groups through explosive contractions, resulting in improved motor unit recruitment, increased peak force production, and enhanced movement efficiency. Recent evidence indicates that explosive training during childhood effectively develops neuromuscular coordination and rate of force development without compromising normal growth when appropriate training loads and supervision are provided.

Another important explanation for the present findings relates to motor development among primary school children. Fundamental movement skills, including running, jumping, balancing, and coordination, continue to mature throughout the elementary school years. Acceleration training provides repeated opportunities for children to refine essential movement components such as push-off mechanics, arm swing coordination, stride rhythm, and dynamic balance. Repetitive practice strengthens neuromotor pathways, improves proprioceptive awareness, and facilitates automatic execution of efficient sprint techniques. Recent research involving young athletes has demonstrated that children who receive structured sprint instruction exhibit superior coordination between stride length and stride frequency compared with peers who rely solely on unstructured physical activity. Such improvements not only enhance sprint performance but also contribute to broader physical literacy and long-term athletic development.

These findings also align with the principles of long-term athletic development, which emphasize that the ages of approximately 7–12 years represent a critical window for enhancing speed, coordination, and neuromuscular control. During this developmental stage, children demonstrate high neural plasticity, allowing technical sprint training to produce substantial improvements without requiring excessive training volume. Therefore, acceleration exercises should emphasize movement quality, gradual progression, enjoyment, and age-appropriate workloads rather than maximal physical loading. When implemented according to pediatric exercise principles, acceleration training contributes not only to improved sprint performance but also to healthier musculoskeletal development, better posture, enhanced confidence, and increased participation in physical activity.

CONCLUSION

This study concludes that acceleration training has a significant positive effect on 60-meter sprint performance among students of Madrasah Ibtidaiyah DDI Pulele. The statistical analysis demonstrated a significant improvement in sprint speed following the intervention, as evidenced by the paired-samples t-test results ($t = 8.361$, $p = 0.000 < 0.05$). The experimental group showed a substantial reduction in sprint time from a pre-test mean of 9.804 ± 0.542 seconds to a post-test mean of 8.473 ± 0.101 seconds, with an average improvement of 1.331 seconds. In contrast, the control group exhibited only a slight improvement, indicating that structured acceleration training was considerably more effective than conventional physical education activities.

From a conceptual perspective, these findings confirm that acceleration training enhances sprint performance by improving neuromuscular coordination, lower-limb explosive force, stride efficiency, and the ability to generate horizontal propulsion during the initial phase of sprinting. Such physiological, biomechanical, and motor adaptations are particularly beneficial for primary school children, whose neuromuscular and musculoskeletal systems remain highly responsive to appropriate training stimuli. Consequently, acceleration exercises not only improve sprint speed but also contribute to the development of fundamental movement skills, physical fitness, and movement competence.

Therefore, acceleration training can be recommended as an effective, safe, and practical training strategy for inclusion in athletics instruction and extracurricular sports programs at the elementary school level. Its implementation is expected to improve students' sprint performance while simultaneously supporting long-term physical development, motor learning, and participation in school-based physical education programs.

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