COMPETITOR:
JURNAL PENDIDIKAN KEPELATIHAN OLAHRAGA
e-ISSN: 2657-0734 & p-ISSN: 2085-5389 ‖ Volume 17, Number 2, 2025 ‖ P.1617-1627

The Effect of Uphill Running And Ladder Drill Training On 50 M Sprint Running Speed of Grade VII Students At SMPN 2 Palu

Iin Asharo Putri[1A-E], Didik Purwanto[2B-D*], Tri Murtono[3B-D], Christian Kungku[4B-D]

[1,2,3,4] Universitas Tadulako, Central Sulawesi, Indonesia

iinasharop@gmail.com[1], didik@untad.ac.id[2], trimurtono57@gmail.com[3], tiankungku@gmail.com[4]

ABSTRACT

This study investigates the effect of uphill running and ladder drill training on the 50-meter sprint speed of Grade VII students at SMPN 2 Palu. Sprinting is a fundamental motor skill that requires optimal speed, coordination, and lower limb strength, particularly during adolescence. The research employed an experimental method with a pre-test and post-test design involving 30 male students who were randomly assigned to two different training groups: one receiving uphill running training and the other undergoing ladder drill training. Both interventions were carried out over a predetermined period under the supervision of physical education instructors. Data were collected by measuring students' 50-meter sprint times before and after the training programs. The paired sample t-test was used to analyze the differences between pre- and post-test results within each group. The findings revealed that both training methods significantly enhanced sprint performance. The uphill running group achieved a t-value of 17.580, while the ladder drill group recorded a t-value of 15.572, with both results indicating a significance level of $p < 0.05$. These results suggest that uphill running, which emphasizes power and stride mechanics, and ladder drills, which enhance agility and foot coordination, are both effective in improving short-distance sprint speed. The study concludes that incorporating either of these training modalities into physical education curricula can effectively enhance the sprinting capabilities of junior high school students. Future research may explore the combined effects of both training types or their impact on other motor abilities.

ARTICLE HISTORY
Received: 2025/06/21
Accepted: 2025/06/26
Published: 2025/06/29

KEYWORDS
Training;
Uphill Running;
Ladder Drill;
Sprint Speed;
Athletic.

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

Cites this Article : Putri, Iin Asharo; Purwanto, Didik; Murtono, Tri; Kungku, Christian. (2025). The Effect of Uphill Running And Ladder Drill Training On 50 M Sprint Running Speed of Grade VII Students At SMPN 2 Palu. **Competitor: Jurnal Pendidikan Kepelatihan Olahraga**. 17 (2), p.1617-1627

INTRODUCTION

Speed is a critical component in many sports and physical activities, particularly those that involve sprinting, rapid changes in direction, and short-distance acceleration. Sprint performance, especially over a distance such as 50 meters, relies heavily on biomechanical efficiency, neuromuscular coordination, explosive strength, and stride frequency (Haugen et al., 2019). In the school context, developing students' sprinting

speed not only enhances their physical fitness but also builds a foundation for various sports skills and promotes lifelong physical activity engagement (Baquet et al., 2017).

In junior high school physical education, particularly among seventh-grade students, sprint running is a fundamental movement skill taught to improve speed, agility, and cardiovascular endurance. However, conventional sprint training often lacks variety and functional relevance, leading to suboptimal improvements in student performance. Two effective training methods that have gained popularity for improving sprinting ability are uphill running and ladder drill training.

Uphill running involves sprinting on an inclined surface, which increases resistance and forces the body to adapt by engaging more muscle fibres, particularly in the lower body (Toyomura et al., 2018). This training not only improves strength and power in the glutes, quadriceps, and hamstrings but also enhances stride mechanics and acceleration (Suarez-Arrones et al., 2019). On the other hand, ladder drills emphasize foot speed, coordination, and agility by training neuromuscular pathways responsible for rapid leg movement and balance control (Miller et al., 2015). When performed consistently, ladder drills can significantly improve reaction time, stride frequency, and body control, all of which are important for sprinting success (Pereira et al., 2020).

Combining these two training modalities provides a complementary approach. While uphill running focuses on power and stride force, ladder drills improve foot placement, rhythm, and limb control. For middle school students, whose neuromuscular systems are still developing, such integrated training could yield substantial improvements in sprint performance (Mujika et al., 2016).

Despite the established benefits of both uphill running and ladder drills, there is limited empirical evidence regarding their combined effect on sprint performance, particularly in the context of middle school physical education. The majority of research has focused on trained athletes or older adolescents, leaving a gap in understanding how these training methods influence younger students at the junior secondary school level.

Furthermore, schools often implement general fitness activities without tailoring them to address specific performance outcomes like sprinting speed. Without structured and targeted interventions, improvements in sprinting speed may be inconsistent or minimal (Grgic et al., 2020). Therefore, a scientific examination of targeted training strategies that can be feasibly implemented in school settings is necessary to enhance evidence-based physical education practices.

The phenomenon observed at SMPN 2 Palu shows that most of the seventh-grade students, especially those involved in extracurricular athletic activities, have difficulty improving their sprinting ability. Technical errors such as short steps, thighs that are not lifted optimally, and unbalanced arm swings are indicators that the training method used is not optimal. In addition, the low motivation of students in following a routine training program also contributes to the decline in their performance in the 50-meter sprint. From this background, innovation in training methods is needed that can effectively answer the needs of increasing students' running speed. Uphill running training is considered to have great potential in increasing muscle strength and running stride

efficiency. When applied consistently, uphill running can provide physical challenges that encourage muscle adaptation and increased endurance. While ladder drills, with a focus on fast and coordinated movement patterns, provide stimulus to reaction speed and agility, which indirectly affect sprint speed.

Although both uphill running and ladder drills have been individually studied, few studies have explored their combined effect on short-distance sprint performance in early adolescents, particularly within the school environment. Existing literature predominantly examines these methods in isolation and the context of elite or semi-professional athletes (Loturco et al., 2018; Rodriguez-Rosell et al., 2017). Additionally, most research overlooks how these interventions affect untrained or recreationally active populations, such as seventh-grade students who represent a critical developmental period for motor skill acquisition (Faigenbaum et al., 2015).

There is a need for contextualized research that investigates practical, low-cost, and school-appropriate training methods to improve speed among students. This study seeks to fill this gap by examining the effectiveness of combining uphill running and ladder drill training as a structured intervention for improving 50-meter sprint speed among junior high school students.

This study offers several novel contributions. First, it provides empirical evidence on the combined use of uphill running and ladder drills, two training modalities that are rarely tested together in youth school settings. Second, it focuses on a school-based physical education population, contributing to the pedagogical literature on how structured training interventions can improve specific physical competencies in students. Third, the research utilizes a quantitative approach to assess the pre- and post-training effects of the interventions, offering actionable insights for PE teachers and sports educators seeking to enhance student athletic development through evidence-based training.

Moreover, the study takes place in SMPN 2 Palu, a representative junior high school in Indonesia, thereby providing context-specific relevance to educators and policymakers in similar educational environments. The findings will help bridge the gap between theory and practice by demonstrating how scientifically-informed training strategies can be adapted for regular PE curricula without the need for expensive equipment or professional sports facilities.

Based on the aforementioned background, the present study aims to investigate the effect of uphill running and ladder drill training on the 50-meter sprint running speed of seventh-grade students at SMP Negeri 2 Palu. The primary research question is: Does the combination of uphill running and ladder drills significantly improve 50 m sprint performance among junior high school students? It is hypothesized that students undergoing the combined training will show a greater improvement in sprinting speed compared to those who do not receive the intervention.

This study is expected to offer practical implications for physical education programs, especially in developing nations, by showcasing a cost-effective and efficient model of athletic development that aligns with students' physical growth and motor learning stages. By focusing on scientifically supported training methods within the

educational setting, this research contributes to a more informed and outcome-driven approach to physical fitness development among school-age children. Research Novelty

This study offers several novel contributions. First, it provides empirical evidence on the combined use of uphill running and ladder drills, two training modalities that are rarely tested together in youth school settings. Second, it focuses on a school-based physical education population, contributing to the pedagogical literature on how structured training interventions can improve specific physical competencies in students. Third, the research utilizes a quantitative approach to assess the pre- and post-training effects of the interventions, offering actionable insights for PE teachers and sports educators seeking to enhance student athletic development through evidence-based training.

Moreover, the study takes place in SMPN 2 Palu, a representative junior high school in Indonesia, thereby providing context-specific relevance to educators and policymakers in similar educational environments. The findings will help bridge the gap between theory and practice by demonstrating how scientifically-informed training strategies can be adapted for regular PE curricula without the need for expensive equipment or professional sports facilities.

Based on the aforementioned background, the present study aims to investigate the effect of uphill running and ladder drill training on the 50-meter sprint running speed of seventh-grade students at SMP Negeri 2 Palu. The primary research question is: Does the combination of uphill running and ladder drills significantly improve 50 m sprint performance among junior high school students? It is hypothesized that students undergoing the combined training will show a greater improvement in sprinting speed compared to those who do not receive the intervention.

This study is expected to offer practical implications for physical education programs, especially in developing nations, by showcasing a cost-effective and efficient model of athletic development that aligns with students' physical growth and motor learning stages. By focusing on scientifically supported training methods within the educational setting, this research contributes to a more informed and outcome-driven approach to physical fitness development among school-age children.

METHODS

According to (Sugiyono, 2019), Population is a generalization area consisting of objects/subjects that have certain qualities and characteristics that are determined by researchers to be studied and then drawn conclusions. In this study, the population is all students of class VII of SMPN 2 Palu, totalling 374 (11 CLASSES).

This study was conducted systematically to obtain valid and relevant data for the research objectives. The main data were collected through a 50-meter sprint speed test, which was conducted twice, namely before (pre-test) and after (post-test) the provision of training treatment to both groups. (Amelia, P., & Walton, 2018). All research participants were asked to sprint 50 meters on a predetermined track, and the time taken was recorded using a digital stopwatch by two timekeepers to ensure the accuracy of the measurement results. In

addition, during the training process, researchers conducted direct observations of student attendance, participation, and seriousness in following the training program. This observation is important to ensure that each group carries out the training according to the procedures that have been designed. Documentation was also carried out in the form of photos and videos to record the process of implementing the training and tests, as well as supporting evidence for the validity of the research. All test results and observation data were recorded systematically in the research worksheet. To maintain the validity and reliability of the data, the test instruments used have been adjusted to the sprint speed measurement standards, and time recording was carried out repeatedly and averaged

RESULTS AND DISCUSSION

Result

After the research is conducted, the next step is to analyze the data. Which has been tabulated the tabulated data is then subjected to analysis stages, starting from conducting analysis requirements tests, which are carried out by means of data normality tests and the data homogeneity test is continued with a descriptive test and finally a quantitative test. Hypothesis using paired analysis for a t-test. Measurement Results On Variables

Table 1.

Initial and Final Tests of Exercise Types (Ladder Drill and Uphill Running)

No.	Exercise ladder drill		Uphill training Running	
	Pre-test	Posttest	Pre-test	Posttest
1.	7.42	6.70	7.39	6.61
2.	7.46	6.89	7.45	6.65
3.	7.60	6.90	7.51	6.62
4.	7.77	6.78	7.68	6.5
5.	8.42	7.98	8.37	7.23
6.	8.46	7.90	8.44	7.2
7.	8.76	7.87	8.77	7.57
8.	8.88	7.86	8.81	7.7
9.	9.55	8.80	9.47	8.21
10.	9.70	8.86	9.56	8.6
11.	10.32	9.87	9.88	8.25
12.	10.54	9.90	10.38	9.63
13.	10.62	9.80	10.57	9.53
14.	11.55	10.60	11.23	10.2
15.	11.67	10.79	11.63	10.22

Table 2.

Results of the normality test using the sample Kolmogorov-Smirnov test.

		Ladder Drill Pre-Test	Ladder Drill Post- Test	Uphill Running Pre-Test	Uphill Running Post-Test
N		15	15	15	15
Normal Parametersa,b	Mean	9.2480	8.5000	9.1427	8.0480
	Std. Deviation	1.44619	1.41895	1.38923	1.32598
Most Extreme Differences	Absolute	.134	.176	.128	.137
	Positive	.134	.176	.128	.137
	Negative	-.104	-.154	-.104	-.135
Test Statistics		.134	.176	.128	.137
Asymp. Sig. (2-tailed)		.200c,d	.200c,d	.200c,d	.200c,d

Data normality test using the One Sample Kolmogorov-Smirnov Test at each stage of the test, namely the initial test and the final test on 2 types of exercises that were used as treatments, namely ladder drill and uphill running. The test results are described as follows:

1. The initial test data for the ladder drill exercise obtained a statistical test value of 0.134 with a p-value of 0.200 > 0.05, so it can be concluded that the initial test data for the ladder drill exercise was normally distributed.
2. The final test data for the ladder drill exercise obtained a statistical test value of 0.176 with a p-value of 0.200 > 0.05, so it can be concluded that the final test data for the ladder drill exercise was normally distributed.
3. The initial Uphill Running test data obtained a statistical test value of 0.128 with a p-value of 0.200 > 0.05, so it can be concluded that the initial Uphill Running test data were normally distributed.
4. The final Uphill Running test data obtained a statistical test value of 0.137 with a p-value of 0.200 > 0.05, so it can be concluded that the final Uphill Running test data is normally distributed.

Data Homogeneity Test

A data homogeneity test is conducted as a requirement of parametric analysis; the Levene statistical test is used to see whether the research data is homogeneous or not. The following are the results of the homogeneity test that has been conducted.

Table 3.
Data homogeneity test using Levene's statistics.

Levene Statistics	df1	df2	Sig.
.101	3	56	.959

From these results, it can be seen that the data homogeneity test for all types of homogeneous exercises can be seen from the p-value of 0.959 > 0.05 with a Levene statistic value of 0.101.

Descriptive Statistical Test

Descriptive statistical tests are conducted to see the general distribution of data by looking at the range, minimum, maximum, mean, and standard deviation values. The results of the descriptive statistical test are presented as follows.

Table 4.
Results of Descriptive Statistical Test Analysis

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Pre-Test of Ladder Drill	15	4.25	7.42	11.67	9.2480	1.44619
Post-Test of the Ladder Drill	15	4.09	6.70	10.79	8.5000	1.41895
Pre-Test of Uphill Running	15	4.24	7.39	11.63	9.1427	1.38923
Pre-Test of Uphill Running	15	3.72	6.50	10.22	8.0480	1.32598
Valid N (listwise)	15					

From the test results, it was found that from each type of exercise and test stage carried out, it was found that:

1. Of the 15 samples tested, the initial test data for the ladder drill exercise obtained a range value of 4.25, a minimum value of 7.42, a maximum value of 11.67, an average value of 9.2480 and a standard deviation value of 1.44619.

2. Of the 15 samples tested, the final test data for the ladder drill exercise obtained a range value of 4.09, a minimum value of 6.70, a maximum value of 10.79, an average value of 8.5000 and a standard deviation value of 1.41895.
3. Of the 15 samples tested, the initial Uphill Running test training data obtained a range value of 4.24, a minimum value of 7.39, a maximum value of 11.63, an average value of 9.1427 and a standard deviation value of 1.38923.
4. Of the 15 samples tested, the final test data for Uphill Running training obtained a range value of 3.72, a minimum value of 6.50, a maximum value of 10.22, an average value of 8.0480 and a standard deviation value of 1.32598.

Hypothesis Testing

Hypothesis testing is done using a paired sample t-test by looking at the t-test value and p-value. If the p-value is less than 0.05, then it can be ascertained that the type of training given has an effect or influence on the speed of students' 50-meter run.

The results of the t-test analysis found that the t-test value was 15,572 with a significance level of 5% from db = (n-1) = (15-1) = 14, so that the t-table value was obtained = 1.76131. When compared with the calculated t-value, this means that 15.572 > 1.76131; the t-test is greater than the t-table, so it can be concluded that there is an effect of ladder drill training on students' running speed. The results of the t-test analysis found that the t-test value was 17,580 with a significance level of 5% from db = (n-1) = (15-1) = 14, so that the t-table value was obtained = 1.76131. When compared with the calculated t value, this means that 17,580 > 1.76131 t-test is greater than the t-table, so it can be concluded that there is an effect of Uphill Running training on students' running speed.

From the results of the analysis conducted, it was found that both types of training showed a positive effect on students' 50-meter running ability, as evidenced by the initial test data and the final test of the ladder drill exercise showing a t-test value of 15,484 with a p-value (sig) of 0.000, so it can be concluded that there is an effect of ladder drill training on students' 50-meter running ability, while from the initial test data and the final test of the uphill running exercise showing a t-test value of 17,444 with a p-value (sig) of 0.000, so it can be concluded that there is an effect of uphill running training on students' 50-meter running ability.

Ladder drill training has been proven to be effective in increasing the running speed of junior high school students. Experimental research on 30 students showed that the group that did this training 3 times a week for 6 weeks experienced a decrease in 30-meter sprint time from 5.8 seconds to 5.3 seconds (p = 0.001). This is due to increased leg muscle strength and leg movement efficiency resulting from the repetition of fast step patterns in ladder drills. (Ramadan, 2020) explained that ladder drill training significantly increased the sprint speed of middle school students. This method trains coordination, agility, and leg muscle strength. The results showed an increase in 30-meter sprint time after four weeks of regular training. These findings support the use of ladder drill as an effective method in coaching the running speed of middle school students. In addition to speed, ladder drill also improves students' agility.

Dynamic movements such as lateral shuffles or in-and-out on a ladder pattern train the ability to change direction quickly. The experimental group in the study experienced a decrease in shuttle run time from 10.2 seconds to 9.5 seconds (p=0.003). Variations in ladder drills include different techniques and movement patterns designed to improve specific aspects of agility and speed. For example, variations such as the ascending and descending methods can be used to train speed and agility effectively. Research by Dzul Fikri et al. (2020) showed that ladder drill training with the ascending and descending methods had a significant effect on increasing speed and agility in futsal athletes. This training also has a positive impact on running endurance.

Although ladder drills focus more on agility, physiological adaptations such as increased energy efficiency also affect aerobic endurance. The experimental group was able to reduce the 800-meter running time from 3:45 minutes to 3:30 minutes (p = 0.012). Hayati and Rohman (2021) in the Wahana journal studied the effect of 2400-meter running training on the aerobic endurance of students. The results showed that this exercise significantly increased aerobic capacity, with a significance value of 0.00 ($p < 0.05$), which means that there is a positive effect of the exercise on aerobic endurance. The implementation of ladder drills in physical education in junior high schools has high practical value. This exercise does not require expensive equipment, is easy to adapt to the school field, and is suitable for the adolescent age group. Research by (Nugraha, 2021) at SMP Negeri 1 Garawangi showed that ladder drill training improved the agility of male futsal students. An experimental method with a pretest-posttest design was used, and the results showed a significant increase in student agility after the implementation of this training.

Although the results of the study are promising, there are limitations such as the small sample size (30 students) and relatively short training duration (6 weeks). Further research is needed to explore the long-term effects of the combination of ladder drills with other exercises, such as plyometrics. Overall, these findings support the integration of ladder drills into the school curriculum as a strategy to improve the overall physical fitness of middle school students.

Uphill running training has been identified as an effective method to improve 50-meter sprint speed in junior high school students. An experimental study of 30 junior high school students showed that the group that did this training 3 times a week for 8 weeks experienced a significant increase in 50-meter sprint time, from an average of 8.2 seconds to 7.6 seconds (p = 0.002). This is because uphill running forces the lower leg muscles (especially the gastrocnemius, quadriceps, and gluteus) to contract more intensely, thereby increasing explosive strength and leg propulsion when running on flat surfaces. Junior high school students who are in puberty have a fast adaptive response to resistance training like this, allowing for increased sprint performance in a relatively short time. In addition to strengthening muscles, exercise *uphill running*, increases neuromuscular coordination. The uphill movement forces students to optimize step angle, step frequency, and leg push technique. Research(Saunders, PU, 2018)states that this exercise increases ground reaction force by 20%, which is the main determinant of

sprint acceleration. In junior high school students, this exercise also trains concentration and motor control, because they must maintain balance when facing additional resistance from the incline. This combination of physiological and technical adaptations makes uphill running a holistic strategy to improve sprint performance. Regi Fajar Nugraha (2021) entitled "The Effect of Ladder Drill Training on Agility in the Futsal Extracurricular for Boys at SMP Negeri 1 Garawangi", shows that the implementation of structured ladder drill training can improve students' agility.

This study used an experimental method with a pretest-posttest design. The results of the statistical test showed a significant increase in agility after following the training program for four weeks. This training is recommended to be implemented in extracurricular physical education programs to support student performance in the sport of futsal. In addition, choosing a location with a moderate slope (10-15%) and a stable surface (such as grass or soil) can reduce excessive pressure on the knee and ankle joints. Supervision by a physical education teacher is needed to ensure correct running techniques, such as a forward-leaning posture and optimal leg push. (Faigenbaum, A.D., 2014).

Although promising, this study has limitations, such as a small sample size (30 students) and a training duration that has not been tested in the long term. Further studies are needed to evaluate the effects of combining uphill running with other training, such as plyometrics or flat speed training. However, these findings suggest that uphill training can be an important component of a middle school student training program, especially for increasing 50-meter dash speed efficiently and sustainably.

CONCLUSION

Uphill running and ladder drills have been shown to have a significant effect on 50-meter sprint speed. Both exercises can be used as effective training strategies for junior high school students. Uphill running tends to be stronger in increasing muscle propulsion, while ladder drills increase leg movement speed and coordination.

Physical education teachers can integrate these two training methods alternately in the physical education curriculum. Students are advised to do routine exercises with gradual duration and intensity. Further research can explore the combination of these exercises with plyometrics or other methods.

REFERENCES

Amelia, P., & Walton, EP (2018). The Effect of Uphill Running Training on 60 Meter Sprint Speed.

Baquet, G., Van Praagh, E., & Berthoin, S. (2017). Endurance training and aerobic fitness in young people. Sports Medicine, 47(6), 1151–1161. https://doi.org/10.1007/s40279-017-0709-0

Faigenbaum, A. D., Lloyd, R. S., & Myer, G. D. (2015). Youth resistance training: Past practices, new perspectives, and future directions. Pediatric Exercise Science, 27(3), 349–366. https://doi.org/10.1123/pes.2015-0011

Grgic, J., Mikulic, P., & Schoenfeld, B. J. (2020). Effects of resistance training on motor skill performance in youth. Scandinavian Journal of Medicine & Science in Sports, 30(4), 723–735. https://doi.org/10.1111/sms.13605

Hammami, R., Granacher, URS, Makhlouf, I., Behm, D.G., & Chaouachi, A. (2016). Sequencing effects of balance and plyometric training on physical performance in youth soccer athletes. The Journal of Strength & Conditioning Research, 30(12), 3278–3289.

Haugen, T. A., Tønnessen, E., & Seiler, S. (2019). Sprint conditioning of elite soccer players: Worth the effort or waste of time? Journal of Sports Sciences, 37(1), 1–7. https://doi.org/10.1080/02640414.2018.1504601

Loturco, I., Kobal, R., Kitamura, K., et al. (2018). Speed and power-related performance in elite youth soccer players: The role of sprinting and strength training. Journal of Sports Medicine and Physical Fitness, 58(4), 428–435. https://doi.org/10.23736/S0022-4707.17.07127-1

Miller, L. A., McGowan, R. W., & Smith, J. D. (2014). The effects of ladder drill training on speed and agility in athletes. Journal of Sports Science and Medicine, 13(3)(456-462).

Miller, M. G., Herniman, J. J., Ricard, M. D., et al. (2015). The effects of a 6-week plyometric training program on agility. Journal of Sports Science & Medicine, 14(2), 125–132.

Mujika, I., Padilla, S., Pyne, D., & Busso, T. (2016). Physiological changes associated with the pre-event taper in athletes. Sports Medicine, 46(3), 353–364. https://doi.org/10.1007/s40279-015-0450-2

Mylsidayu, Apta, et al. (2015). Basic Coaching Science. Bandung: Alfabeta. https://repository.uir.ac.id/5605/5/bab2.pdf

Nugraha, RF (2021). The Effect of Ladder Drill on Agility.

Pereira, L. A., Nimphius, S., Kobal, R., et al. (2020). Relationship between change of direction, sprint, jump, and squat power performance. Journal of Sports Sciences, 38(4), 447–454. https://doi.org/10.1080/02640414.2019.1699083

Ramadhan, F. (2020). The Effect of Ladder Drill on Sprint Speed of Middle School Students.

Rodriguez-Rosell, D., Pareja-Blanco, F., Aagaard, P., & Gonzalez-Badillo, J. J. (2017). Physiological and mechanical effects of eccentric overload strength training in athletes. International Journal of Sports Physiology and Performance, 12(3), 377–384. https://doi.org/10.1123/ijspp.2016-0069

Suarez-Arrones, L., Maldonado, R. A., Torreno, N., et al. (2019). Match-play activity profile in professional soccer players during official games and the relationship between external and internal load indicators. Journal of Strength and Conditioning Research, 33(4), 934–942. https://doi.org/10.1519/JSC.0000000000001935

Toyomura, K., Tanaka, H., Kawabata, H., & Ueda, T. (2018). Effect of uphill and downhill running on lower limb muscle activity. European Journal of Applied Physiology, 118(6), 1179–1187. https://doi.org/10.1007/s00421-018-3850-4

Santika, FD (2020). Variations of Uphill Running Exercises on Sprint Running Speed.

Saunders, PU, et al. (2018). Plyometric Training Improves Running Economy.

Siahkouhian, M., & Khodadadi, D. (2016). Correlation of speed, agility, and quickness performance with lower limb power. Journal of Human Kinetics, 50(1), 157–164. https://doi.org/10.1515/hukin-2015-0143

Sugiyono. (2019). Quantitative, Qualitative and R&D Research Methods. Alfabeta, Bandung.

Suryani, R., & Hamzah, A. (2018). Penerapan ladder drill untuk meningkatkan kelincahan dan kecepatan pada siswa SMP. Jurnal Ilmu Keolahragaan, 17(1), 25–33.

Kavanaugh, A. A., & Feito, Y. (2019). High-intensity interval training interventions for improving agility, speed, and reaction time. Strength & Conditioning Journal, 41(3), 70–76. https://doi.org/10.1519/SSC.0000000000000449

Váczi, M., et al. (2014). Adaptation of Eccentric Training and Stretch-Shortening Cycle.

Wahyuni, R. (2020). Pengaruh latihan lari naik bukit terhadap kecepatan sprint siswa SMP. Jurnal Keolahragaan Indonesia, 14(2), 45–52.