12 (1) (2025) 88 - 92

Journal of Physical Education, Health and Sport

https://journal.unnes.ac.id/journals/jpehs

Optimizing Physical Adaptation Sprint Performance Trough Resistance Training in Youth Atlhetes: A Literature Riview

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History Article

Received July 2025
Approved July 2025
Published vol 12 no 1 2025

Keywords

Resistance Training; Youth Athletes; Sprint; LTAD; Physical Performance

Abstract

Long Term Athlete Development (LTAD) program emphasizes trhe importance of continous and structurud physiscal development of athletes according to the stage of growth and maturity of the individual. Resistance training is one of the main components in supporting athletic sprint performance, especially in youth athletes. This study aims to review the effect of resistance training on physiscal adaptation that support improved sprint performance through the litterature riview method. A total 10 relevant scientific articles published between 2014-2024 were thematically analyzed to identify the impact of resistance training ion physical performance variables. The result of this study show that systematically planned resistance training can improve lower extremity muscle strength, sprint acceleration, speed, explosive power, and movement coordination. Methode such as Velocity-Based Training (VBRT), the use of Resistance Wearalbles, the combination od Squats with Sled Towing and Speed-Based Load Setting proved effective in improving sprint performance. Another advantage of resistance training is that it can reduce the risk of injury and support the long-term health of youth athletes. This study emphasizes the importance of including resistance training in LTAD programs for sprint athletes to achive peak performance and prevent the negative effcts of overtraining. Therefore , incorporating resistance training into youth sprint program sis essential for optimizing performance outcomes. Future studies should explore individualized resistance training protocols tailord to differant stages of athlete development.

How to Cite

Maheswari, D. S., Afifah, H. M., & Sembada, R. (2025). Optimizing Physical Adaptation Sprint Performance Trough Resistance Training in Youth Atlhetes: A Literature Riview. Journal of Physical Education, Health and Sport, 12 (1), 88-92.

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p-ISSN 2354-7901
e-ISSN 2354-8231

INTRODUCTION

The development of youth athletes, especially in athletics, requires a systematic training strategy over a long period of time. Long-term athlete development (LTAD) is a long-term development approach that emphasizes the importance of training programs according to the biological age of athletes. Psychological maturity of athletes is rather than based only on the chronological age of athletes. LTAD. Is one of the strategic approaches taken as an international reference (Granacher et al., 2016). Recent studies have extended LTAD by integrating specific models for different exercises and physical components, considering technical ability, developmental stage, and maturity(Pichardo et al., 2018). From the introductory phase of the movement to elite-athlete development competititon, LTAD emphasizes a continous the athlete's potential (Till et al., 2022). LTAD goes through seven stages from basic movement skill development to training for elite competition and transition to lifelong activities(Lloyd et al., 2015).

Resistance training has become a popular training method, and it can effectively improve athletic performance in a variety of sports, including track and field. Both young and professional athletes benefit from increased muscular strength, speed endurance and sport-specific abilities gained from resistance training(Lesinski et al., 2016). In this regrad, resitance training (RT) has been recognized as an important element in supporting the development of muscular fitness, atlhetics performance, and injury prevention in youth athletes. Within the LTAD framework, resistance training helps athletes to improve muscular strength, optimize coordination, flexibility, speed, and endurance according to the developmental stage of youth athletes (Varghese et al., 2022). It has been shown that weight training can improve athlete performance in various fields. Weight training can improve maximal strength, sprint time, and vertical jump height, especially when combined with conventional resistance training (García-Valverde et al., 2022). In addition to improving performance, resistance trainin ghas a role in maintaining long-term health and has tehepotential to reduce injury risk in youth athletes(Lesinski et al., 2016).

Despite the proven benefits of resistance training in youth athlete development. There remains limited understanding regarding how specific resistance training methods can be systematically integrated within the LTAD framework to enhance sprint performance outcomes.

This study aims to review the effect of resistance training on physical adaptation that supports improved sprint performance through a literature review method. Analyze the impact of various resistance training methods on sprint performance variables in youth athletes, and evaluate how these methods align with the stages of the LTAD model to optimal athletic development

The novelty of this research lies in it's focus on integrating modern resistance training strategies, such a velocity-based training and load specific modalities, whitin LTAD stages, offering a structured model for enhancing sprint–specific physical development in youth athletes.

METHOD

This research uses a literature review with a narrative review method to support a topic in building theory and context or validating the research focus (Stratton, 2019). The topic covered in this study was resistance training in sprint with total 0f 10 articles. The corresponding articles within the range range of years from 2014 to 2024 are reviewed, and conclusions are drawn from the topic under study.

Article data collection uses several keywords such as "resistance training", "athletic athletes", "youth athletes", "speed", "sprint", to facilitate the article search process. The appropriate number of articles was then analyzed using thematic analysis techniques, which aim to mark patterns and similarities in themes that emerge from various sources classified (Lochmiller, 2021). Existing data were identified that focused on the influence of resistance training, the importance of resistance training, and its impact on the ability of youth athletes in sprint performance. A table was then created consisting of columns for journal title, author name, year of publication, and research result to extract all articles.

RESULTS AND DISCUSSION

Based on the coverage of scientific articles that are in accordance with the research topic, they are identified and then reviewed to see the characteristics or similarities that appear. 10 scientific articles reviewed after going through the extraction process through the application of criteria provide results that resistance training needs to be applied during training programs to improve the sprint performance of athletic athletes. Of the 10 articles there are (3 articles) discussing the

Article Title/Journal Name	Research Result	Author Name/Year
Tittle: The Use of Wearable Resistance and Weighted Vest for Sprint Performancr and Kinematic Review and Meta-Analysis Journal: Scientific Sport	(WV) in field spsorts caused kinematic changes related to sprint performancr. However, WV is more suitable for athletes who depend on stride length and WR is more suitable for athletes who depend on stride frequency	Author: Gabriel Felipe Bertochi, et.al Year: 2024
Tittle: Optimizing Resistance Training for Sprint and Endurance Athletes Balancing Positive and Negative Adaptions. Journal: Sport Medicine	This research states that resistance training adaptations are generally benefical for improving sprint performance and endurance (running) and reducing the risk of injury	Author: Baas Van Hooren, et.al Year: 2024
Tittle: The effectiveness of adjusting Resistance Training Loads Through Velocity-Based Trchniques in Experienced Sprinter: a Case Series Study Journal: Frontiers in Physiology	This study compared weight-adjusted squat training (AL) and non-weight-adjusted squat training (NAL) interventious. The result showed that weight-adjusted squat training performed squat close to the expected speed at 70%-75% of 1 RM, but with a largeer difference at 80%-85% of 1 RM. The AlL training group had a greater percentage of improvement from each test than te NAL group. Based on the result of the analysis, it can be concluded that the AL training strategy in velocity-based training (VBT) is needed to train the daily strength od sprinters.	Author: Violeta Munōz de la Cruz, et.al Year: 2024
Tittle: Velocity Bassed Resistance Training on 1 RM, Jump, Sprint Performance: A Systematic Review of Clinical Trials Journal: Journal Sports	Based on 22 researcers who met the systematic review criteria fron the relust of the analyzed studies, it can be concluded that velocity based resistance training (VBRT) is and effective method for improving 1 RM, vertical jumpa, and sprint performance	Author: Mateo Baena-Marin, et.al Year: 2022
Tittle: Combined Squat and Light Load Resisted Sprint Trainning for Imporving Athletic Performance Journal: The Journal Strength and Conditioning Research	The research conducted gave result on squat (SQ) training provides an increase in sprint time of 20-30 m. the provision of squat (SQ) and light-load sled towing (LST) training programs showed an increas in sprint times of 0-30 m, 10-20 m, and 10-30 m. it was concluded that LST training (12.5% BM) combined with low medium load squat training can be an effectife stimulus to improve leg strength, jumping ability, change direction ability, and sprint performance	Author: Fernando Pareja – Blanco, et.al Year: 2021
Tittle: Resistance Training in Youth Athletes Improves Athletic Performance: A Systemaic Review Journal: SLACK Journal	Result were obtained from 21 articles that were selected and reviewed. The fearures that appeared in the review of this studies included running (7), Power (12), strength (13), Endurance (5), sport-specific skiolls (6) and agility (2). It can be concluded that compared to not applaying resistance training, systematic resistance training can significantly improve power, strength, endurance, running speed, and spor-specific skill in adolecent population.	Author: Antigone S. Vesci, et.al Year: 2017
Tittle: The effect of Resistance Training on Sprint and Endurance Performance Maters Athletes: A Narrative Riview Journal: Journal of Fitness Research	The result of this study state that by applying intensive strngth training in a sprinter's training program, the change in specific performance is usually smaller, but significant (p<0,05), with time. Sprint running is reduced bt 2-4% this means that resistance teaining program improve physiological factors affect sprint performance	Author: Luke Delveccio, et.al Year: 2015
Tittle: Sprinting Performance and Resistence – Based Training Interventions A Systematic Review Journal: The Journal of Strength and Conditioning Research	The result of this study draw conclusions from 5 studies that have met the inclusion criteria. Tree of the 5 studies revealed a statistical increase in sprint performance in the 30 meter sprint. It can be said that resistance training interventions can improves sprint performance	Author: Bolger Richard, et.al Year: 2015
Tittle: Increase in Lower Body Strength Transfer Positively to Sprint Performance: A Systematic Review with Meta – Analysis Journal: Journal Sport Med	The result of this research showed that the significant of sprint performance improvement was influenced by training sessions, resistance per week and rest interval between resistance training sets. Sprint performance improvrment was not affected by the age and height of the athletes. The applied resistance training method paid attention to the average load intensity (% of 1 RM), training session, number of repititions, per training set, It can be said. That lower extermity strngth training has a positive influence on sprint peformance	Author: Lurent B. Seitz Year: 2014
Tittle: Effect of two Different Resistance Training Programers on the Sprinting Performance of Men Aged 10 to 25 Journal: Thesis Submitted to the Faculty of Health Science, Univesity of Johannesburg	This stidy compered the treatment group and the control group found positive corellative result between the percentage of muscle mass in 60 m (p=21), 80 m (p=,01) and 100 m (p=,019) with explosive power and 40 m sprint time (p-,015)	Author: Licinda Pienaar Year: 2014

impact of resistance training on endurance, (9 articles) discussing resistance training on strength, (2 articles) discussing the impact of resistance training on change of direction (9 articles) discussing the impact of resistance training on speed, (3 articles) discussing the impact of resistance training on vertical jump (1 article) which discusses the impact of resistance training on injury. The sprint variable is the most common because it is the main variable discussed in all articles. Strength and speed variables are the dominant variables because they are the main indicators of improving sprint performance. Other variables, such as explosive power, change of direction endurance, and injury, are variables that are affected by resistance training but not discussed in many articles.

The application of training protocols to optimize muscle strength includes longer exercise duration, higher intensity, and fewer reps per set (Lesinski et al., 2016). (Turkmani et al., 2022) Previous studies reported that combining resistance training and athletic training was shown to improve endurance performance, muscle strength, and other physical components that support athletic performance (Peng, 2023). Increased strength ability can reduce the risk of overtraining injuries in young athletes (Vesci et al., 2017). Properly designed resistance training has the effect of strengthening bones, muscles, and tendons, which can reduce the risk of injury (Myers et al., 2017). Furthermore, Sprint training, when combined with resistance training, can increase stride length, power production, and acceleration with a focus on speed and coordination (Prasad & Jesintha, 2023). Although resistance training has an influence on performance, it needs to be balanced with endurance training to prevent negative adaptations such as excessive muscle hypertrophy, which can reduce sprint performance or endurance (Van Hooren et al., 2024). Resistance training does cause medium-to-large gains in muscle strength and power in young athletes (Lesinski et al., 2016). Resistance training produces significant increases in muscle strength and moderate (Orange et al., 2020). Training durations more than 23 weeks, 5 sets each exercise, 6-8 repetitions per set, 80-90% 1 RM intensity, and 3-4 minutes of rest in between sets are the ideal Resistance Training parameters for youth (Lesinski et al., 2016).

Numerous studies that examine various training techniques and prescriptions have demonstrated the effectiveness of resistance training variables, including load, sets, and frequency, significantly increase muscle strength when compared with no exercise. The best outcomes are obtained with higher-load, multiset prescriptions (Currier et al., 2023). Furthermore (Arabas et al., 2023) , it was discovered that different training modalities (free weight training versus machine weights) resulted in differing strength gains, specifically pointing out that people with lower levels of strength benefited more from certain training equipment. Additionally, (Palmizal et al., 2025) note that a thorough planning approach highlights the significance of progressive overload and individualization in maximizing strength gains from resistance training regimens.

Previous research showing improvements in performance parameters after intervention suggests that a resistance program designed for adolescents can produce significant improvements in athletic abilities such as running and jumping (Murray et al., 2024).

CONCLUSION

Resistance training significantly improves the physical performance of sprint athletes by enhancing lower-body muscle strength. Based on 10 scientific articles reviewed, various important components in sprinting, such as lower extremity muscle strength, explosive power, acceleration speed, jumping, and Movement coordination, have been shown to improve through resistance training designed and adapted to the biological developmental stage and needs of young athletes. Future research is recommended as a follow-up step by examining the effectiveness of resistance training programs on young athletes in athletics in terms of biomechanics, neuromuscular, and athletic performance.

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