



THE EFFECT OF PLYOMETRICS EXERCISE THROUGH AGILITY LADDER DRILL ON IMPROVING PHYSICAL ABILITIES OF 13–15-YEAR-OLD VOLLEYBALL PLAYERS

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Abstract

Study purpose. The purpose of this study was to test the plyometrics training method through agility ladder drills to increase leg muscle power, agility, and aerobic endurance in 13-15-year-old volleyball players.

Materials and methods. The research method used was an experiment with a one-group pretest-posttest and pretest-posttest control group approach. The participants were 30 male volleyball players weighing 57-67 kilograms and 157-170 cm in height. Vertical jump, agility t-test, and multistage fitness test were used in this study. Data gathering methods included observation and tests, while data analysis methods included descriptive analysis, Wilcoxon, and Mann-Whitney nonparametric analysis.

Results. Descriptive data revealed a difference in the mean value of the pretest and posttest of the experimental group. Furthermore, it also showed a difference in the mean value of the experimental and control groups. In the Wilcoxon test, the value of Asymp. sig(2-tailed) was $0.006 < 0.05$, agility was $0.001 < 0.05$, and endurance was $0.001 < 0.05$. In the Mann-Whitney test, the value of Asymp. sig(2-tailed) was $0.416 > 0.05$, agility was $0.00 < 0.05$, and endurance was $0.00 < 0.05$.

Conclusions. In the experimental group, the posttest score is higher than the pretest score on power, agility, and endurance. In volleyball players aged 13-15 years, there is a significant effect, with the experimental group outperforming the control group in terms of power, agility, and endurance. As a result, one of the recommended exercises for young volleyball players is the plyometrics training method using an agility ladder drill.

Keywords: plyometrics, agility ladder drill, young volleyball players.

Introduction

Volleyball is a game sport that is carried out in teams (Zech et al., 2021). Nowadays, volleyball is very popular among parents, teenagers, and children (Duan, 2021; Rahmi & Bachtiar, 2020). People playing volleyball have different goals such as recreation, improving health, and achievement (Young, et al, 2011; Suh et al, 2022; Bloshchynsky et al, 2019). Achievements in volleyball certainly require more effort to get maximum results (Kolev, 2020).

Achievements in volleyball are carved from an early age, so it is necessary to implement long-term coaching development for athletes (Balyi, Way & Higgs, 2013). The study states that to achieve the top, a systematic and planned

program is needed and is supported by adequate internal and external parties (Bompa & Buzzichelli, 2019).

In coaching achievement at a young age, especially in volleyball, of course, putting forward technical training with good technique would be able to maximize performance (Chevrier et al, 2016). But in essence, volleyball is related to physical conditions (Taware, Bhutkar & Surdi, 2013). Therefore, one of the maximum supporters of a technique is supported by excellent physical condition.

Volleyball players at a young age need training with a multilateral approach so that by applying this concept they can provide motion enrichment in carrying out techniques (Wicaksono & Hidayatullah, 2022). It is hoped that with the amount of physical literacy provided, young athletes can demonstrate more complex technical movements (Brendan et al., 2014). Studies suggest that exercise improves physical ability in young athletes need to emphasize varied movements

that involve brain and muscle coordination (Faigenbaum et al., 2016)

Athletes require high physical literacy at a young age to avoid injury, whereas physical exercise is more than just running motions, physical training is based on cognitive and affective knowledge (Faigenbaum et al., 2016). As a result, when considering volleyball physical training, especially around the age of 13-15 years, it differs greatly from physical training for older athletes (Buško et al., 2012). In-depth research, however, is required in the application of physical training for volleyball players aged 13 to 15.

A coach's responsibility is to establish an adequate training program for the chronological ages of young athletes (Wicaksono et al., 2022). To maximize accomplishment in old age, a scientific method is required (Alsaudi, 2020). Athletes are not obliged to become champions at a young age, but they can display the essential methods that have been acquired, such that the highest level of champions is in maturity (Sulistiyo et al., 2021). As a result, the purpose of a long-term training program is to build, maximize, and sustain peak performance.

Using the plyometrics training approach is one of the attempts made to increase a volleyball player's physical capacity (Jastrzbeski et al., 2014). Plyo means to increase, and metrics are a measurement (Radcliffe & Farentinos, 2015). This plyometrics workout is distinguished by quick leaping and jumping motions, which entail fast eccentric and concentric phases (Radcliffe & Farentinos, 2015). According to research, the plyometrics exercise approach offers several advantages for boosting power, agility, flexibility, and endurance (Pratama et al., 2018).

According to observational research employing an interview strategy, some trainers claimed that physical activity is highly required, but at a young age, it prioritizes basic techniques. This is correct, but it is not absolute that just technique is taught since when athletes walk together, they go forward, sideways, and backward methods, especially while jumping, which is extremely difficult when there is no element of physical condition (Yudhistira & Tomoliyus, 2020). This is consistent with other studies indicating that physical fitness is vital in performing technical motions when practicing and competing (Yudhistira et al., 2021; Yulianto & Yudhistira, 2021)

Furthermore, numerous instructors indicated that plyometrics training was not allowed to be offered to young athletes due to the risk of injury, then the coach stated that various conditions must be met before plyometrics training, such as the athlete being able to complete squats weighing 1.5 body weight (Jones & Ledford, 2012). This is right, but it is not suitable; in reality, plyometrics exercise, when done with the appropriate training dose, has a favorable influence on the development of young athletes' physical condition (Rublely et al., 2011).

Gjinovci et al. (2017) conducted an experimental study on young volleyball players for 12 weeks utilizing a skill-based plyometrics training approach, with the outcomes of plyometrics training having a substantial influence on 20-meter running, leaping ability, and effectively lowering body mass index. Then, according to Idrizovic (2018), physical activity utilizing the plyometrics training approach gives a considerable rise in ball medicine throwing and the capacity to leap vertically in junior volleyball competitors.

However, according to Fathi et al. (2019), plyometrics training had no significant effect on enhancing jump height, sprint time, and flexibility in teenage volleyball players.

According to the findings of Maćkała et al (2021), plyometric training did not result in a substantial increase in vertical jump performance in volleyball players. Based on the studies discovered, there are contradictions in earlier research.

Studies on plyometrics training methods are still being debated (Ramirez-Campillo et al., 2020; Watkins et al, 2021). Furthermore, Gjinovci et al. (2017) claimed that there is still little study that investigates plyometric training approaches mixed with various motions to promote volleyball abilities. The goal of this study is to investigate the plyometrics training approach employing agility ladder drills to develop leg muscular strength, aerobic endurance, and agility in volleyball players aged 13-15 years.

Materials and methods

Study participants

The research method used was a field test experiment with a one-group pretest-posttest design approach and a pretest-posttest control group design approach. Participants were 30 male volleyball players aged 13-15 years with a height of 157-170 cm and a body weight of 57-67 kilograms. All participants were given a pretest in the first stage, with the instruments utilized being a vertical leap test, an agility t-test, and a multistage fitness test. Following the discovery of the findings, the data were sorted from highest to lowest. The A-B-B-A pattern was then used to carry out the ordinal pairing match mechanism. As a result of this method, the experimental group was divided into 15 players who used the plyometrics training method with agility ladder drills and 15 players who were in the control group and used different training methods. This research was assisted by two trainers to prepare and carry out the treatment using the plyometrics agility ladder drill method in each group of 15 volleyball players aged 13-15 years. Players were given treatment 2 times a week for 16 meetings. In one exercise session, approximately 90 minutes to 120 minutes of exercise time are given with adjusted exercise dose settings.

Study organization

Participants were given treatment in the form of a plyometrics training method using agility ladder drill facilities for 16 meetings where treatment was given 2 times a week. The minimum presence of participants is 80%. The vertical leap test was used to assess the leg muscle power instrument, the agility t-test was used to measure the agility test instrument, and the multistage fitness test was used to measure the aerobic endurance test instrument. The procedure for performing plyometrics agility ladder drill exercises is as follows: the first player is guided to jog for 3 to 5 minutes to increase the pulse. The athlete is then guided to do static and dynamic stretching for approximately 20 to 30 minutes. At last, the athlete executes the program that has been prepared. The following is a plyometrics training program based on an agility ladder drill (Table 1).

Statistical analysis

The SPSS version 23 program was used to process the data. The first analysis was a descriptive analysis in which the

Table 1. Plyometrics agility ladder drill training program

Week	Meeting	Exercise Items	Exercise Dosage
1-2	1-3	Item 1: Rabbit hops Item 2: Straddle hops squat Item 3: Hopscotch	Volume (rep × sets): 6 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	4-6	Item 1: Ladder taps (left leg) Item 2: Ladder taps (right leg) Item 3: Single leg hops (left leg) Item 4: Single leg hops (right leg)	Volume (rep × sets): 10 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
3-4	7-9	Item 1: Shuffle Item 2: Snake Jump Item 3: Straddle hops Item 4: Skiers jump	Volume (rep × set): 10 × 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	10-12	Item 1: Two-foot hoops – zigzag pattern Item 2: Single foot hops zig-zag pattern (left right) Item 3: Single foot hops zig-zag pattern (right leg)	Volume (rep × set): 15 × 2 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
5-6	13-15	Item 1: Forward-backward hop Item 2: Cross legs Item 3: Fight shuffle Item 4: Two forward, one back	Volume (rep × set): 10 × 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	16-18	Item 5: Lateral in out Item 6: Carioca Item 7: Ski jumps	Volume (rep × set): 15 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal

Table 2. Descriptive analysis results of pretest and posttest power agility and endurance

Group	Variable	Pretest				Posttest			
		Min	Max	Mean	SD	Min	Max	Mean	SD
Experiment	Power	41	56	49.73	4.803	43	56	50.53	4.596
	Agility	17.12	18.34	17.61	0.47211	16.45	18.00	17.12	0.32887
	Endurance	38.09	48.08	44.69	3.24535	48.08	51.9	50.32	1.02517
Control	Power	42	56	49.27	4.511	41	56	49.13	4.882
	Agility	17.09	18.23	17.65	0.40813	17.09	18.24	17.65	0.41500
	Endurance	38.10	48.08	43.91	2.76913	38.11	48.04	43.71	2.62126

lowest, maximum, standard deviation, and mean values were presented. The second stage was Wilcoxon data analysis to check if the pretest and posttest effects differed in the experimental group. The next step is to examine the Mann-Whitney data to determine if there is a difference between the experimental and control groups' post-test outcomes. Deciding if the significance value is <0.05 and there is a substantial difference. A descriptive study of physical abilities such as power, agility, and aerobic endurance is provided below (Table 2).

Results

The Wilcoxon analysis of the Asymp.sig (2-tailed) value on the leg muscle power variable yielded $0.006 < 0.05$. This finding indicates that there was a considerable improvement in leg muscular power between the pretest and posttest findings. The Asymp. (sig2-tailed) value in the agility variable is $0.001 < 0.05$. In other words, the data suggest that there is a considerable variation in agility outcomes between

Table 3. The results of the pretest-posttest comparison of the experimental group based on Wilcoxon analysis

Variable	Asymp. sig (2-tailed)
Pretest – power	0.006
Posttest – power	
Pretest – Agility	0.001
Posttest – Agility	
Pretest – Endurance	0.001
Posttest – Endurance	

the pretest and posttest. The Asymp. (sig2-tailed) value in the endurance variable is $0.001 < 0.05$. As a result, the result revealed a substantial difference between the pretest and posttest outcomes of aerobic endurance (Table 3).

The Mann-Whitney analysis of the Asymp. sig (2-tailed) value for the power variable is $0.416 > 0.05$ as shown in

the table, indicating that there is no significant difference between the post-test values of the experimental and control groups. The experimental group's mean value is 50.53, while the control group's mean value is 49.13. The agility variable has an Asymp.sig (2-tailed) value of $0.000 < 0.05$, indicating a significant difference between the experimental and control groups' post-test values. The experimental group's mean value is 17.12, while the control group's mean value is 17.65. The Asymp.sig (2-tailed) value for the endurance variable is $0.00 < 0.05$ which indicated a significant difference between the results of the post-test values of the experimental and control groups. The mean value in the experimental group is 50.32, while the mean value in the control group is 43.71 (Table 4).

Table 4. The results of the post-test comparison of the experimental and control groups based on Mann Whitney analysis

Group	Variable	Mean	Asymp. sig (2-tailed)
Experiment	Power	50.53	0.416
Control		49.13	
Experiment	Agility	17.12	0.000
Control		17.65	
Experiment	Endurance	50.32	0.000
Control		43.71	

Discussion

According to the Wilcoxon analysis of the pretest and posttest findings, the Asymp.sig (2-tailed) value for the power variable in the experimental group was $0.006 < 0.05$. The Asymp.sig (2-tailed) value in the agility variable is $0.001 < 0.05$. The value of Asymp.sig (2-tailed) in the endurance variable is $0.001 < 0.05$. The results described in the power, agility, and endurance variables can be interpreted as meaning that there is a significant difference between the pretest and posttest results, such that the posttest score is higher than the pretest value, as evidenced by the average posttest score of 50.53 on the power variable, 17.12 on the agility variable, and 50.32 on the endurance variable.

Based on the Mann-Whitney analysis, which compared the results of the experimental and controls posttests, the value of Asymp.sig(2-tailed) on the power variable is $0.416 > 0.05$, the agility variable is $0.00 < 0.05$, and the endurance variable is $0.00 < 0.05$. The results show that the power variable has no significant effect between the experimental posttest and posttest control groups, however, the agility and endurance variables have a significant effect between the experimental posttest and control posttest groups.

Volleyball players frequently use complex movements such as passing to their teammates and fast jumping up before smashing, and they are ready to return to their starting position to defend and attack again, which is done repeatedly for an extended period (Boichuk et al., 2017; Budiman, 2016). Of course, physical fitness is crucial not just for older athletes, but also for young athletes (Faigenbaum et al., 2016). Furthermore, smart approaches, strategies, and tactics are, of course, supported by a strong body (Franchini et al, 2007). The author's plyometrics training program for volleyball players aged 13-15 years has a considerable effect

on physical performance, including leg muscle power, agility, and endurance.

According to the authors' findings, although the plyometrics approach employing the agility ladder drill did not significantly affect leg muscle power, the mean value in the experimental group was 50.53, while the control group was 49.13. Previous studies have confirmed this, and while the increase is not statistically significant, it still has a positive effect on the physical performance of young players for a further stage, because young players are still in the development stage, and this performance may continue to improve with proper time workout program and maturity (Edoya et al., 2015; Markovic, 2007; Vassil & Bazanovk, 2012).

On the agility variable, the experimental group had an average score of 17.12, while the control group received an average score of 17.65. The endurance variable had a mean value of 50.32, while the control group had a mean value of 43.71. This is consistent with prior research showing that plyometric exercises improve cardiovascular and neuromuscular fitness (Wang & Zhang, 2016). Plyometric exercises improve maximum strength, running speed, endurance, and agility (Wang & Zhang, 2016). As a result, plyometrics training is an effective approach for young volleyball players to increase their athletic ability (Vassil & Bazanovk, 2012)

Plyometrics is a method that includes motions like bounding, jumping, and hopping (Ichailidis et al., 2013). Plyometric exercises have fast lengthening and shortening cycles (Booth & Orr, 2016; Meszler, 2019). Studies have shown that plyometrics exercises use stretching and shortening phases that develop during rapid eccentric and concentric muscle contractions (Markovic et al., 2007; Markovic & Mikulic, 2010).

Because the muscles store energy during the eccentric phase and swiftly release it during the concentric phase, this exercise improves muscle strength and power (Davies, 2015). As a result, plyometrics training is advised as one of the volleyball training recipes (Ziv & Lidor, 2010).

The common misconception that plyometric activities are only employed by adult athletes is untrue. According to studies, plyometrics exercises are not only taught to adult athletes but also to youngsters and teenagers (Meylan & Malatesta, 2009). Plyometrics training has a positive effect on the physical capacities of young athletes (Martínez-lópez et al., 2012). Furthermore, one of the program recommendations for injury prevention is the plyometrics exercise program (Weber, Lam & Mcleod, 2016). Understanding the proper notion of plyometrics will undoubtedly have a positive impact on the development of young athletes (Akaruk et al., 2011). However, it is very important to understand and clarify the specifics for compiling a plyometrics exercise program for volleyball players aged 13-15 years, since errors in compiling plyometrics exercise programs can lead to the overload of the musculoskeletal system and the occurrence of Osgood-scatter disease at the age of 10-19 years (Ozmen & Aydogmus, 2017; Patel, 2002)

According to the study, the prerequisite for plyometrics training is that athletes can complete squats weighing 1.5 times their body weight in one lift so that there is no injury in the provision of plyometrics training (Baechle & Earle, 2008). Another viewpoint holds that low and high-

impact plyometrics exercises performed once or twice a week in conjunction with strength training are unquestionably safe and useful in a variety of sporting activities (Diallo et al, 2001; Faigenbaum et al, 2009; Ingle et al, 2006; Potdevin et al, 2011; Rubley et al, 2011). Another study found that plyometrics training is done twice a week in young athletes, the rest time is 72 hours, the number of foot contacts each training session is 50–60 and climbs 80–120, the number of repetitions is 6–15, and as many as 3–4 exercises should be done. 2–4 sets were completed (Edoya et al., 2015)

Furthermore, plyometrics training for young volleyball players is extremely different from plyometrics training for senior volleyball players (Medeni et al., 2019). To build a plyometrics training program at a young age, one must examine the hormonal, neurological, and muscular systems, as this is related to puberty or growth acceleration that impacts teenagers when performing movements (Myer et al, 2013)

Plyometrics training employing agility ladder drill media is a type of exercise variation that helps young athletes avoid boredom (Alviana, Mintarto, & Hariyanto, 2020; Padrón et al, 2021). Trainers have commonly employed ladder drill exercises to promote coordination, agility, speed, balance, and other skills (Robin, & Raj, 2019; Ng, Cheung & Raymond, 2017). As a result, plyometrics training using an agility ladder drill is one way that is appropriate for young volleyball players.

Trainers can combine several actions to provide motion enrichment, as a foundation for advanced plyometrics training, and to build brain and muscle synchrony (Padrón et al, 2021; Milroy, 2010). Trainers must learn how to set training doses such that the plyometrics training supplied does not injure young athletes. The success of an exercise is an individual loading adjustment and regular exercise dosage; we compare the effect of physical exercises on the body with the effect of hormones of the endorphin group (hormones of happiness), and the dose must be regulated and adjusted effectively (Gronwald et al, 2020).

Conclusions

Based on the findings and discussions, the comparison of the pretest and posttest in the experimental group has a substantial effect on leg muscular power, agility, and endurance. Furthermore, a comparison of the posttest findings and mean values in the experimental and control groups revealed that the experimental group that received the plyometrics training approach through the agility ladder drill, had a substantial influence on leg muscular power, agility, and endurance. Thus, the plyometrics training approach with the agility ladder drill is one of the suggested exercises for young volleyball players and other sports that need complicated motion enrichment.

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Conflict of interest

All authors declare there is no conflict of interest in this study

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ВПЛИВ ПЛІОМЕТРИЧНИХ ВПРАВ НА СПРИТНІСТЬ НА КООРДИНАЦІЙНІЙ ДРАБИНІ НА ПОКРАЩЕННЯ ФІЗИЧНИХ ЗДІБНОСТЕЙ ВОЛЕЙБОЛІСТІВ ВІКОМ 13–15 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 4 табл., 39 джерел.

Мета дослідження. Метою цього дослідження було перевірити метод пліометричних тренувань шляхом виконання вправ на спритність на координаційній драбині для підвищення сили м'язів ніг, спритності та аеробної витривалості у волейболістів віком 13-15 років.

Матеріали та методи. Як метод дослідження використовували експеримент із попереднім і підсумковим тестуванням на одній групі та попереднім і підсумковим тестуванням на контрольній групі. Учасниками були 30 волейболістів чоловічої статі вагою 57-67 кілограмів і зростом 157-170 см. У цьому дослідженні використовували вертикальний стрибок, Т-тест на спритність і багатоетапний фітнес-тест. Методи збору даних включали спостереження та тести, а методи аналізу даних включали описовий аналіз, критерій Вілкоксона та непараметричний аналіз Манна-Уїтні.

Результати. Описові дані виявили різницю в середньому значенні попереднього та підсумкового тестування експериментальної групи. Крім того, вони також показали різницю в середньому значенні експериментальної та контрольної груп. У критерії Вілкоксона величина двосторонньої асимптотичної значущості (Asymp. sig (2-tailed)) становила $0,006 < 0,05$, спритність – $0,001 < 0,05$, витривалість – $0,001 < 0,05$. У критерії Манна-Уїтні величина двосторонньої асимптотичної значущості (Asymp. sig (2-tailed)) становила $0,416 > 0,05$, спритність – $0,00 < 0,05$, витривалість – $0,00 < 0,05$.

Висновки. В експериментальній групі бал підсумкового тестування вищий за бал попереднього тестування за силою, спритністю та витривалістю. У волейболістів віком 13–15 років спостерігається достовірний ефект, при цьому експериментальна група перевершує контрольну за показниками сили, спритності та витривалості. У зв'язку із цим однією з рекомендованих вправ для юних волейболістів є метод пліометричних тренувань з використанням вправ на спритність на координаційній драбині.

Ключові слова: пліометрика, вправи на спритність на координаційній драбині, юні волейболісти.

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