BUKTI KORESPONDENSI ARTIKEL PADA JURNAL INTERNASIONAL BEREPUTASI

PENGUSUL
Dr. Harry Pramono, M. Si / NIDN 0019105905

UNIVERSITAS NEGERI SEMARANG

Yth. Penilai
Pada Usulan PAK

Bersama dengan surat ini, saya bermaksud menyertakan bukti bukti korespondensi proses artikel pada Jurnal Internasional dengan judul "The Effect of Plyometrics Exercise through Agility Ladder Drill on Improving Physical Abilities of 13–15-Year-Old Volleyball", yang dimuat pada Physical Education Theory and Methodology [Teorìâ ta Metodika Fìzičnogo Vihovannâ], edisi Vol. 23 No. 2, 28 April 2023, ISSN (p): 1993-7989, ISSN (e) : 1993-7997, hal : 199-206. Adapun susunan kronologi bukti korespondensi terdiri dari beberapa poin, pada tabel di bawah ini:

No	Tanggal	Aktivitas
1.	17 November 2022	Pembuatan akun, submit artikel pada sistem OJS
2.	17 November 2022	Mendapatkan balasan dari Editor in chief melalui email otomatis dari sistem jurnal
3.	5 Januari 2023	Mendapatkan penataan layout dari Editor untuk dikirimkan ke reviewer melalui OJS
4.	13 Januari 2023	Artikel dikirimkan Editor masuk dalam proses Review dan mendapatkan catatan dari reviewer
5.	21 Januari 2023	Mendapatkan Notifikasi/pemberitahuan oleh Editor adanya revisi Artikel melalui OJS
6.	22 Januari 2023	Mendapatkan Notifikasi/pemberitahuan adanya revisi Artikel melalui E-mail
7.	26 Januari 2023	Mengirimkan hasil Revisi ke OJS
8.	25 Februari 2023	Mendapatkan Notifikasi/pemberitahuan oleh Editor bahwa revisi telah diterima melalui OJS
9.	26 Februari 2023	Mendapatkan Notifikasi/pemberitahuan oleh Editor bahwa revisi telah diterima melalui e-mail
10.	26 Februari 2023	Mendapatkan Notifikasi/pemberitahuan oleh Editor terkait pembayaran yang akan dilakukan melalui OJS dan diterimanya artikel hasil revisi yang akan publish
11.	18 Maret 2023	Mendapatkan Notifikasi/pemberitahuan oleh Editor terkait cara pembayaran dan jumlah pembayaran melalui OJS
12.	18 Maret 2023	Mendapatkan Notifikasi/pemberitahuan terkait cara pembayaran dan jumlah pembayaran melalui e-mail
13.	20 Maret 2023	Melakukan pembayaran fee dan mendapatkan invoice dari untuk publish
14.	21 Maret 2023	Mengirimkan Bukti pembayaran dan balasan penerimaan pembayaran dari Editor melalui OJS
15.	22 Maret 2023	Mendapatkan Notifikasi/pemberitahuan dari e-mail terkait artikel memasuki tahapan production pada OJS
16.	17 April 2023	Mendapatkan Notifikasi/pemberitahuan di OJS terkait artikel telah diupload di galley dan telah dilayout pada OJS
17.	28 April 2023	Journal Publish pada web jurnal dan artikel pdf telah muncul

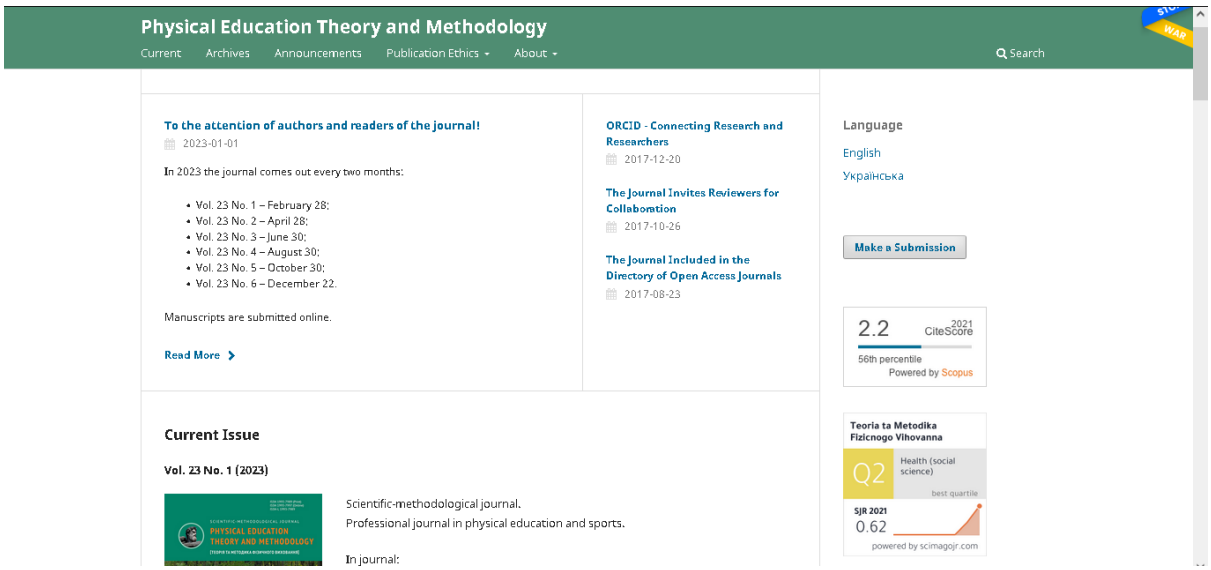
Demikian, agar dapat menjadi periksa.
Terimakasih
Semarang, 28 April 2023
Hormat saya,

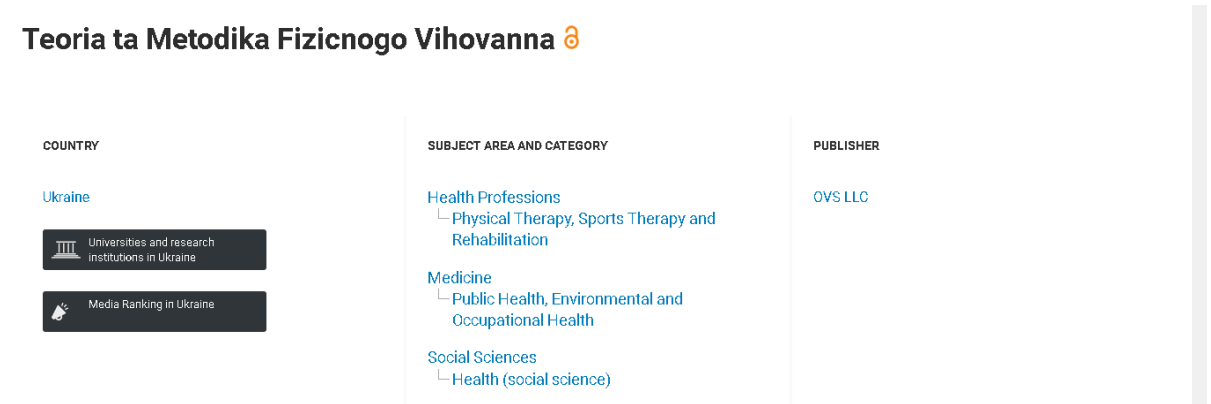
Harry Pramono

KRONOLOGI KORESPONDENSI PUBLIKASI ARTIKEL PADA JURNAL INTERNASIONAL BEREPUTASI DAN BERFAKTOR DAMPAK

Judul	: The Effect of Plyometrics Exercise through Agility Ladder Drill on Improving Physical Abilities of 13–15-Year-Old Volleyball
Jurnal	: Physical Education Theory and Methodology [Teorìâ ta Metodika Fìzičnogo Vihovannâ]
Volume	: 23
Nomor	: 2
Tanggal publikasi	: 28 April 2023
ISSN (p)	: 1993-7989 (print)
ISSN (e)	: 1993-7997 (online)
Hal	: 199-206
Penerbit	: OVS LLC, Kharkiv, Ukraine
SJR jurnal	: 0.617 (2021)
Quartile	: Q2 (Scopus)
SNIP	: 0.535 (2021)
Cite Score	: 2.2 (2021)
Penulis	: Harry Pramono, Tandiyo Rahayu, Dewangga Yudhistira

Bukti indexing jurnal:



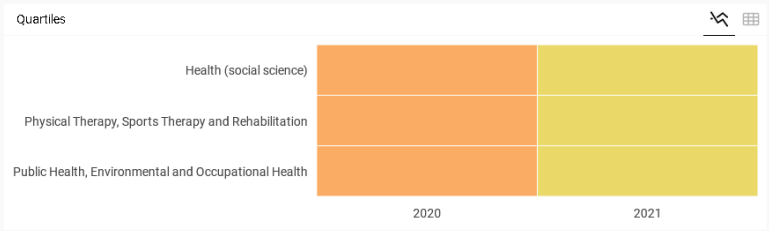


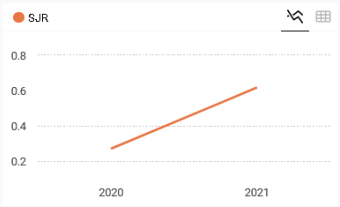
H-INDEX	PUBLICATION TYPE	ISSN
8	Journals	19937989, 19937997

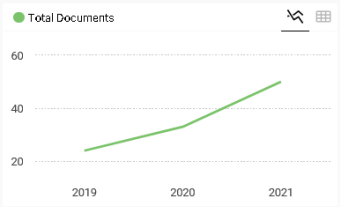
COVERAGE	INFORMATION
2019-2021	Homepage How to publish in this journal

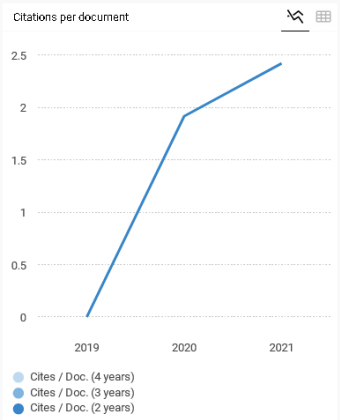
SCOPE

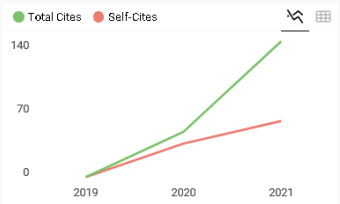
Physical Education Theory and Methodology [Teorìâ ta Metodika Fizičnogo Vihovannâ] is an international research-and-methodology journal established in 2000. It publishes research papers on physical education of children, teenagers and student youth, physical rehabilitation and sports training. The purpose of the journal is to inform about and introduce the results of applied and fundamental research in physical education and sports. The Editorial Board primarily considers submissions focusing on physical education or sports training, or physical rehabilitation; containing a simulated experimental situation, clearly defined independent variables (factors controlled in the experiment are indicators that characterize the process of physical education or sports training, or physical rehabilitation), as well as dependent variables that characterize the effectiveness of the experimental training program; medicobiological, psychophysiological, and psychological indicators used in the study provide additional information to explain the effectiveness of the experimental training program.

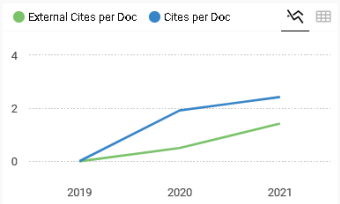


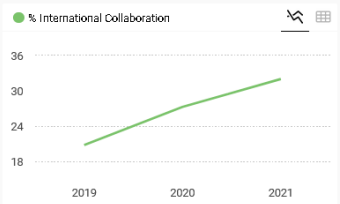


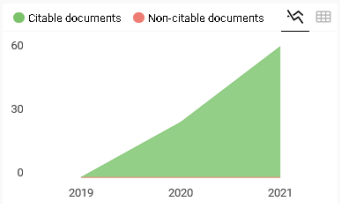


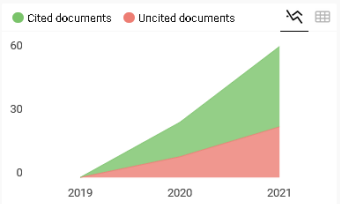












Source details

Teoria ta Metodika Fizicnogo Vihovanna

Open Access

Scopus coverage years: from 2019 to 2022

Publisher: OVS LLC

ISSN: 1993-7989 E-ISSN: 1993-7997

Subject area: Social Sciences: Health (social science) | Health Professions: Physical Therapy, Sports Therapy and Rehabilitation | Medicine: Public Health, Environmental and Occupational Health

Source type: Journal

CiteScore 2021
2.2

SJR 2021
0.617

SNIP 2021
0.535

Improved CiteScore methodology

CiteScore 2021 counts the citations received in 2018-2021 to articles, reviews, conference papers, book chapters and data papers published in 2018-2021, and divides this by the number of publications published in 2018-2021. Learn more >

CiteScore 2021

$$2.2 = \frac{237 \text{ Citations } 2018 - 2021}{107 \text{ Documents } 2018 - 2021}$$

Calculated on 05 May, 2022

CiteScoreTracker 2022

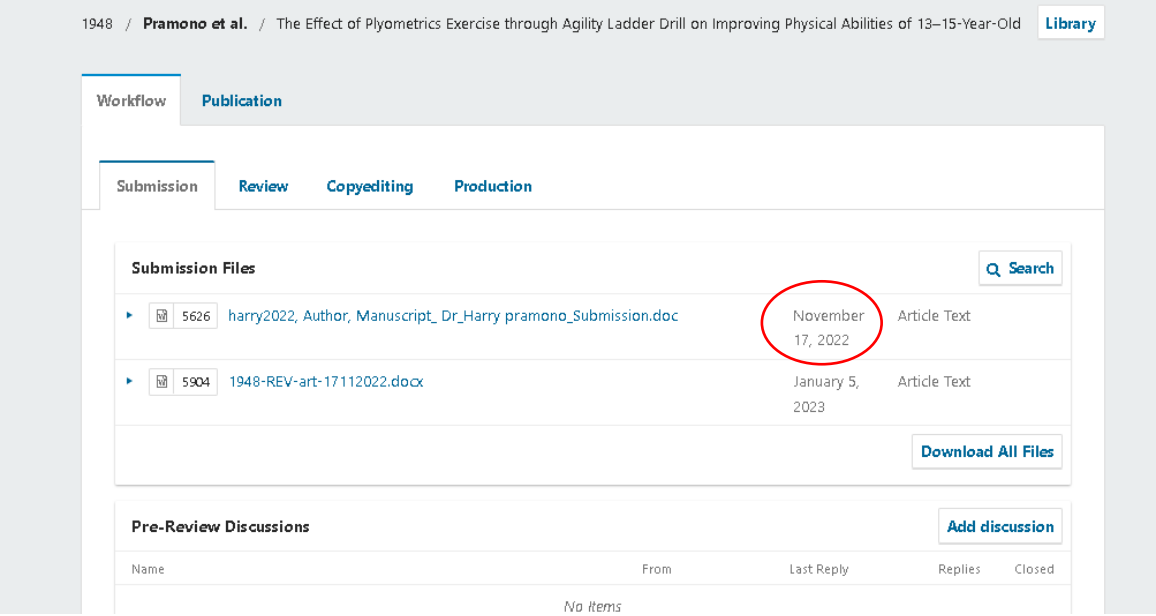
$$1.9 = \frac{401 \text{ Citations to date}}{207 \text{ Documents to date}}$$

Last updated on 05 April, 2023 • Updated monthly

CiteScore rank 2021

RINCIAN KRONOLOGI KORESPONDENSI PUBLIKASI ARTIKEL PADA JURNAL INTERNASIONAL BEREPUTASI

Pembuatan akun dan submit Artikel pada sistem OJS, [17 November 2022]



The Effect of Plyometrics Exercise through Agility Ladder Drill to Improve Physical Ability of 13-15 Year Old Volleyball Players

Harry Pramono[1ABCDE], Tandiyo Rahayu[1ABCDE], Dewangga Yudhistira[1ABCDE],
[1]Faculty of Sport Sciences, Universitas Negeri Semarang, Semarang, Indonesia
*Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Manuscript Preparation (letter D) and/or Funds Collection (letter E) are not sufficient grounds for inclusion in the author's team. This is stated in the recommendations of ICMJE, which guide our editorial office.

Corresponding Author: Harry Pramono: hpr4mono@mail.unnes.ac.id

Abstract

Objectives. 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 0.001<0.05, and endurance 0.001<0.05. In the Mann-Whitney test, the value of Asymp. sig(2-tailed) was 0.416>0.05, agility 0.00<0.05, endurance, 0.00<0.05. **Conclusion**: 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 (Buko 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 & Hidayatullah, 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 (Sulistiyono 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, coordination, 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 (Rubley 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 Makaa 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 (Country 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. 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 x sets) : 6 x 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 x sets) : 10 x 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	7-9	Item 1: Shuffle Item 2: Snake Jump Item 3: Straddle hops Item 4: Skiers jump	Volume (rep x set) : 10 x 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal

3-4	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 x set) : 15 x 2 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	13-15	Item 1: Forward-backward hop Item 2: Cross legs Item 3: Fight shuffle Item 4: Two forward, one back	Volume (rep x set) : 10 x 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
5-6	16-18	Item 5: Lateral in out Item 6: Carioca Item 7: Ski jumps	Volume (rep x set) : 15 x 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal

Statistical analysis.

The SPSS version 23 program was used to process the data. The first analysis was a descriptive analysis in which the 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. Descriptive analysis results of pretest and posttest power agility and endurance

Group	Variable	Pretest				Postest			
		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	.47211	16.45	18.00	17.12	.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	.40813	17.09	18.24	17.65	.41500
	Endurance	38.10	48.08	43.91	2.76913	38.11	48.04	43.71	2.62126

Results

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
Postest – power	
Pretest – Agility	0.001
Postest – Agility	
Pretest – Endurance	0.001
Postest – Endurance	

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

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	

The findings of the Mann-Whitney analysis are shown in Table 4. 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.

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).

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 (Bachle & 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 (Malina, 1998; Roemmich & Rogol, 1995).

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 physical exercise to a drug, 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.

Acknowledgment

The author would like to thank the Semarang State University, Faculty of Sports Science, for their assistance in completing this research appropriately. Furthermore, the authors would like to thank the team for assisting in the collection of research data, which allowed this study to proceed successfully.

Conflict of interest

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

References

Akaruk, H. U. M., Inchester, J. A. B. W., Adowski, J. E. S., & Zaplicki, A. D. A. M. C. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *The Journal of Strength & Conditioning Research*, *25*(12), 3311-3318.

Alsaudi, A. T. B. D. (2020). The Influence of Drill Exercise and Eye Coordination Foot Methods Toward the Smash Skill of Badminton. In *1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)* (pp. 76-82). Atlantis Press.

Alviana, S. I., Mintarto, E., & Hariyanto, A. (2020). The Effect of Exercise with Ladder Drill Slaloms and Carioca on Speed and Agility. *International Journal for Educational and Vocational Studies*, *2*(1), 103-108.

Baechle, T. R., & Earle, R. W. (Eds.). (2008). *Essentials of strength training and conditioning*. Human kinetics.

Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Human Kinetics.

Bloshchynsky, I., Kovalchuk, R., Balendr, A., Aloshyna, A., Bahas, O., Mozolev, O & Prontenko, V. (2019). The conceptual basis of the organization of volleyball team training.

Boichuk, R., Iermakov, S., & Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage JPES ®. *Journal of Physical Education and Sport*, *17*(1), 327–334. https://doi.org/10.7752/jpes.2017.01048

Booth, M. A., & Orr, R. (2016). Effects of Plyometric Training on Sports Performance. *Strength & Conditioning Journal*, *38*(1), 30-37.

Bompa, T. O., & Buzzichelli, C. (2019). *Periodization-: theory and methodology of training*. Human kinetics.

Brendan, J., Tompsett, C., Burkett, B., & Mckean, M. R. (2014). Development of physical literacy and movement competency: A literature review. *Journal of fitness research*, *3*(2), 53-74.

Budiman, I. A. (2016). Development model of volleyball spike training. *International Journal of Sports Physical Education, Sport, and Health*, *3*(3), 466–471.

Buśko, K., Michalski, R., Mazur, J., & Gajewski, J. (2012). Jumping abilities in elite female volleyball players: Comparative analysis among age categories. *Biology of Sport*, *29*(4), 317-319.

Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching*, *11*(3), 410-421.

Davies, G. (2015). Current concepts of plyometrics exercise. *The International Journal of Sports Physical Therapy*, *10*(6), 760–786.

Diallo, O., Dore, E., Duche, P., & Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training program on physical performance in prepubescent soccer players. *Journal of sports medicine and physical fitness*, *41*(3), 342.

Duan, C. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal*, *60*(5), 4299-4306.

Edoya, A. A., Miltenberger, M. R., & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: a systematic review. *The Journal of Strength & Conditioning Research*, *29*(8), 2351-2360.

Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *British journal of sports medicine*, *50*(1), 3-7.

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *The Journal of Strength & Conditioning Research*, *23*, S60-S79.

Fathi, A., Hammami, R., Moran, J., Borji, R., Sahli, S., & Rebai, H. (2019). Effect of a 16-week combined strength and plyometric training program followed by a detraining period on athletic performance in pubertal volleyball players. *The Journal of Strength & Conditioning Research*, *33*(8), 2117-2127.

Franchini, E., Nunes, A. V., Moraes, J. M., & Del Vecchio, F. B. (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of physiological anthropology*, *26*(2), 59-67.

Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *Journal of sports science & medicine*, *16*(4), 527.

Gronwald, T., Törpel, A., Herold, F., & Budde, H. (2020). Perspective of dose and response for individualized physical exercise and training prescription. *Journal of Functional Morphology and Kinesiology*, 5(3), 48.

https://doi.org/10.3390/jfmk5030048

Ichailidis, Y. I. M., Fatouros, I. G., Primpa, E., Michailidis, C., Avloniti, A., Chatzinikolaou, A., & Kambas, A. (2013). Plyometrics' trainability in preadolescent soccer athletes. *The Journal of Strength & Conditioning Research*, *27*(1), 38-49.

Idrizovic, K., Gjinovci, B., Sekulic, D., Uljevic, O., João, P. V., Spasic, M., & Sattler, T. (2018). The effects of 3-month skill-based and plyometric conditioning on fitness parameters in junior female volleyball players. *Pediatric exercise science*, *30*(3), 353-363.

Ingle, L., Sleap, M., & Tolfrey, K. (2006). The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of sports sciences*, *24*(9), 987-997.

Jastrzbeski, Z., Wnorowski, K., Mikolajewski, R., Jaskulska, E., & Radziminski, L. (2014). The effect of a 6-week plyometric training on explosive power in volleyball players. *Baltic Journal of Health and Physical Activity*, *6*(2), 1.

Jones, N. B., & Ledford, E. (2012). Strength and conditioning for Brazilian jiu-jitsu. *Strength & Conditioning Journal*, *34*(2), 60-69.

Kolev, P. (2020). Research of adolesencent volleyball palayers intrinsic motivation for achievement of high sports results. *Research in Kinesiology*, *48*.

Malina, R. M. (1998). Growth and maturation of young athletes: Is training for sport a factor. *Sports and children*, 133-161.

Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British journal of sports medicine*, *41*(6), 349-355.

Markovic, G., Arkovic, G. O. M., Ukic, I. G. O. R. J., & Ilanovic, D. R. M. (2007). Effects of sprint and plyometrics training on muscle function and athletic performance. *Journal of Strength and*

Conditioning Research, *21*(2), 543–549. https://doi.org/10.1519/R-19535.1

Markovic, G., & Mikulic, P. (2010). Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine*, *40*(10), 859-895.

Martínez-lópez, E. J., Benito-martínez, E., Hita-contreras, F., Lara-sánchez, A., & Martínez-amat, A. (2012). *Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes*. *August*, 727–735.

Maćkała, K., Synówka, A., Ćorluka, M., & Vodicar, J. (2021). Impact of Plyometric Training on the Power of Lower Limbs in Moderately Advanced Female Volleyball Players. *Acta Kinesiologica*, *15*(1), 5-12.

Medeni, Ö. Ç., Turgut, E., Çolakoğlu, F. F., & Baltacı, G. (2019). Plyometric training combined with jump rope training in female adolescent volleyball players. *Türkiye Klinikleri Sağlık Bilimleri Dergisi*, *4*(3), 261-268.

Meszler, B. (2019). European Journal of Integrative Medicine Combined strength and plyometric exercise training improves running economy and muscle elastic energy storage and re-use in young untrained women. *European Journal of Integrative Medicine*, *28*(November 2018), 86–91. https://doi.org/10.1016/j.eujim.2019.05.004

Meylan, C., & Malatesta, & D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *The Journal of Strength & Conditioning Research*, *23*(9), 2605-2613.

Milroy, T. (2010). Correlation between an Athletes' Consideration of Future Consequences and Their Improvement in Strength, Speed, and Agility with a Six Week Training Program. *Unpublished Master's Thesis). Bozeman, Montana: Montana State University*.

Negra, Y., Chaabene, H., Stöggl, T., Hammami, M., Chelly, M. S., & Hachana, Y. (2020). Effectiveness and time-course adaptation of resistance training vs. plyometric training in prepubertal soccer players. *Journal of Sport and Health Science*, *9*(6), 620-627.

Ng, R. S., Cheung, C. W., & Raymond, K. S. (2017). Effects of 6-week agility ladder drills during recess intervention on dynamic balance performance. *Journal of Physical Education and Sport*, *17*(1), 306.

Padrón-Cabo, A., Lorenzo-Martínez, M., Pérez-Ferreirós, A., Costa, P. B., & Rey, E. (2021). Effects of plyometric training with agility ladder on physical fitness in youth soccer players. *International Journal of Sports Medicine*, *42*(10), 896-904.

Pratama, N. E., Mintarto, E., Kusnanik, N. W., & Pratama, N. (2018). The influence of ladder drills and jump rope exercise towards speed, agility, and power of limb muscle. *Journal of Sports and Physical Education*, *5*(1), 22-29.

Potdevin, F. J., Alberty, M. E., Chevutschi, A., Pelayo, P., & Sidney, M. C. (2011). Effects of a 6-week plyometric training program on performances in pubescent swimmers. *The Journal of Strength & Conditioning Research*, *25*(1), 80-86.

Radcliffe, J., & Farentinos, R. (2015). *High-Powered Plyometrics, 2E*. Human kinetics.

Rahmi, S., & Bachtiar, I. (2020). The Contribution the Physical Condition on Underhand Serve Ability in Volleyball of Elementary School Students in Makassar City. In *3rd International Conference on Education, Science, and Technology (ICEST 2019)* (pp. 296-299). Atlantis Press.

Robin, K. V., & Raj, Y. L. (2019). Impact of ladder training on the agility performance of footballers. *International Journal of Yogic, Human Movement and Sports Sciences*, *4*(1), 1.

Roemmich, J. N., & Rogol, A. D. (1995). Physiology of growth and development: its relationship to performance in the young athlete. *Clinics in sports medicine*, *14*(3), 483-502.

Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research*, *25*(1), 129-134.

Suh, Y. I., Kim, J., Lee, S., Han, S., & Park, S. H. (2022). A qualitative investigation of leisure benefits for social and psychological health among international volleyball players living in South Korea. *International Journal of Qualitative Studies on Health and Well-being*, *17*(1), 2131216.

Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Teorìâ ta Metodika Fìzičnogo Vihovannâ*, *21*(2), 173-179.

Taware, G. B., Bhutkar, M. V., & Surdi, A. D. (2013). A profile of fitness parameters and performance of volleyball players. *Journal of Krishna Institute of Medical Sciences University*, *2*(2), 48-59.

Vassil, K., & Bazanovk, B. (2012). The effect of plyometric training program on young volleyball players in their usual training period. *Journal of Human Sport and Exercise*, *7*(1), S34-S40.

Wang, Y., & Zhang, N. A. (2016). Effects of plyometric training on soccer players. *Experimental and therapeutic medicine*, *12*(2), 550-554.

Watkins, C. M., Gill, N. D., Maunder, E., Downes, P., Young, J. D., McGuigan, M. R., & Storey, A. G. (2021). The Effect of Low-Volume Preseason Plyometric Training on Force-Velocity Profiles in Semiprofessional Rugby Union Players. *The Journal of Strength & Conditioning Research*, *35*(3), 604-615.

Weber, M. L., Lam, K. C., & McLeod, T. C. V. (2016). The effectiveness of injury prevention programs for youth and adolescent athletes. *International Journal of Athletic Therapy and Training*, *21*(2), 25-31.

Wicaksono, D., Hidayatullah, F., Kristiyanto, A., & Purnama, S. K. (2022). The Effect of Training Based on Part And Whole Combinations on Smash Techniques Improvement in Volleyball Sports for 11-12 Year Old Athletes. *Teorìâ Ta Metodika Fìzičnogo Vihovannâ*, *22*(1), 62-69.

Young, M. E. M., Goslin, A., Potgieter, N., Nthangeni, S., & Modise, J. (2011). Sport and recreation participation preferences in the Botswana Defence Force: sport and recreation participation. *African Journal for Physical Health Education, Recreation and Dance*, *17*(sup-1), 134-145.

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences*, *9*(5), 1051–1057. https://doi.org/10.13189/saj.2021.090527

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences*, *8*(5), 211–216. https://doi.org/10.13189/saj.2020.080508

Yulianto, W. D., & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science*, *9*(3), 60-65.

Zech, A., Hollander, K., Junge, A., Steib, S., Groll, A., Heiner, J., ... & Rahlf, A. L. (2021). Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. *Journal of sport and health science*.

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. *Scandinavian journal of medicine & science in sports*, *20*(4), 556-567.

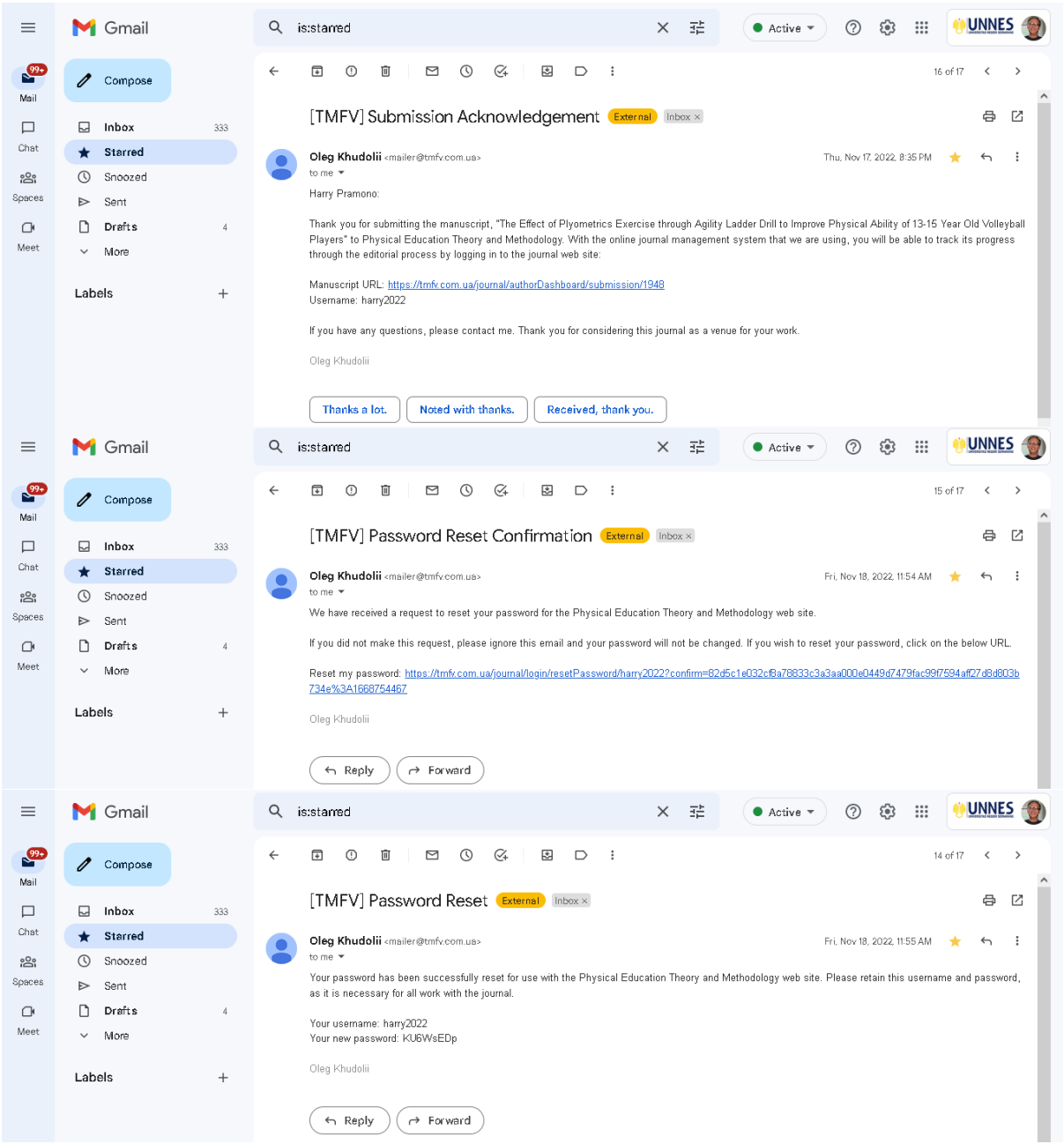
Information about the authors:

Harry Pramono : hpr4mono@mail.unnes.ac.id ; https://orcid.org/0000-0002-9673-5823 ;
Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekarang, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229

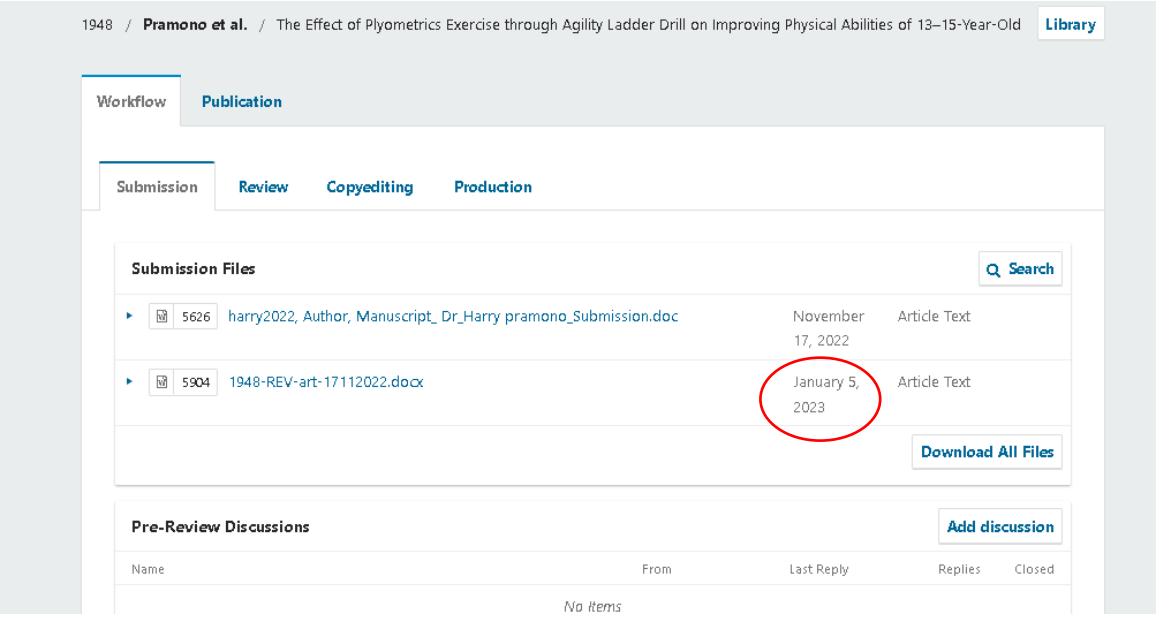
Tandiyo Rahayu : tandiyorahayu@mail.unnes.ac.id **:** https://orcid.org/0000-0002-8690-6377 ;
Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekarang, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229

Dewangga Yudhistira : dewanggayudhistira@mail.unnes.ac.id ; https://orcid.org/0000-0002-4194-1283 ; Department of Sport Coaching Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229

Mendapatkan balasan dari Editor in chief melalui email otomatis dari sistem jurnal [17 November 2022]



Mendapatkan penataan layout dari Editor untuk dikirimkan ke reviewer melalui OJS [5 Januari 2023]



1 **The Effect of Plyometrics Exercise through Agility Ladder Drill to Improve Physical Ability of 13-15 Year Old Volleyball Players**

2 Abstract

3 **Objectives.** 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 0.001<0.05, and endurance 0.001<0.05. In the Mann-Whitney test, the value of Asymp. sig(2-tailed) was 0.416>0.05, agility 0.00<0.05, endurance, 0.00<0.05. **Conclusion**: 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.

4 **Keywords: Plyometrics, agility ladder drill, young volleyball players**

5 Introduction

6 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).

7 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).

8 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.

9 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)

10 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 (Buko et al, 2012). In-depth research, however, is required in the application of physical training for volleyball players aged 13 to 15.

11 A coach's responsibility is to establish an adequate training program for the chronological ages of young athletes(Wicaksono & Hidayatullah, 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 (Sulistiyono et al, 2021). As a result, the purpose of a long-term training program is to build, maximize, and sustain peak performance.

12 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, coordination, flexibility, and endurance (Pratama et al, 2018).

13 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)

a. 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 (Rubley et al, 2011).

14 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.

15 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 Makaa 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.

16 Studies on plyometrics training methods are still being debated (Country 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.

17 Materials and methods

18 *Study participants.*

19 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.

20 *Study organization*

21 *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:

22 ***Table 1.*** *Plyometrics agility ladder drill training program*

23 ***Week***	**24** ***Meeting***	**25** ***Exercise Items***	**26** ***Exercise Dosage***
27	**29**	**31** *Item 1: Rabbit hops*	**34** *Volume (rep x sets) : 6 x 3 on one exercise item*
		32 *Item 2: Straddle hops squat*	
	30 *1-3*	**33** *Item 3: Hopscotch*	**35** *Rest between reps: 10-15 seconds*
			36 *Rest between sets: 60 seconds*
28 *1-2*			**37** *Intensity: moderate – maximal*
	38	**40** *Item 1: Ladder taps (left leg)*	**44** *Volume (rep x sets) : 10 x 3 on one exercise item*
		41 *Item 2: Ladder taps (right leg)*	
	39 *4-6*	**42** *Item 3: Single leg hops (left leg)*	**45** *Rest between reps: 10-15 seconds*
		43 *Item 4: Single leg hops (right leg)*	**46** *Rest between sets: 60 seconds*
			47 *Intensity: moderate – maximal*
48	**50**	**52** *Item 1: Shuffle*	**56** *Volume (rep x set) : 10 x 4 on one exercise item*
		53 *Item 2: Snake Jump*	
		54 *Item 3: Straddle hops*	**57** *Rest between reps: 10-15 seconds*
	51 *7-9*	**55** *Item 4: Skiers jump*	
			58 *Rest between sets: 60 seconds*
			59 *Intensity: moderate – maximal*
49 *3-4*			

	60 **61** *10-12*	**62**	*Item 1: Two-foot hoops – zigzag pattern*	**65** *Volume (rep x set) : 15 x 2 on one exercise item*
		63	*Item 2: Single foot hops zig-zag pattern (left right*	**66** *Rest between reps: 10-15 seconds*
		64	*Item 3: Single foot hops zig-zag pattern (right leg)*	**67** *Rest between sets: 60 seconds*
				68 *Intensity: moderate – maximal*
69 **70** *5-6*	**71** **72** *13-15*	**73**	*Item 1: Forward-backward hop*	**77** *Volume (rep x set) : 10 x 4 on one exercise item*
		74	*Item 2: Cross legs*	
		75	*Item 3: Fight shuffle*	**78** *Rest between reps: 10-15 seconds*
		76	*Item 4: Two forward, one back*	**79** *Rest between sets: 60 seconds*
				80 *Intensity: moderate – maximal*
	81 **82** *16-18*	**83**	*Item 5: Lateral in out*	**86** *Volume (rep x set) : 15 x 3 on one exercise item*
		84	*Item 6: Carioca*	
		85	*Item 7: Ski jumps*	**87** *Rest between reps: 10-15 seconds*
				88 *Rest between sets: 60 seconds*
				89 *Intensity: moderate – maximal*

90 *Statistical analysis.*

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

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

93 Group	**94 Variable**	**95 Pretest**									
		99	Min	**100**	Max	**101**	Mean	**102**	SD	**103**	Min
97 98 Experiment	**107** Power	**108**	41	**109**	56	**110**	49.73	**111**	4.803	**112**	43
	116 Agility	**117**	17.12	**118**	18.34	**119**	17.61	**120**	.47211	**121**	16.45
	125 Endurance	**126**	38.09	**127**	48.08	**128**	44.69	**129**	3.24535	**130**	48.08
134 135 Control	**136** Power	**137**	42	**138**	56	**139**	49.27	**140**	4.511	**141**	41
	145 Agility	**146**	17.09	**147**	18.23	**148**	17.65	**149**	.40813	**150**	17.09
	154 Endurance	**155**	38.10	**156**	48.08	**157**	43.91	**158**	2.76913	**159**	38.11

163 Results

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

165 Variable	**166 Asymp. sig (2-tailed)**
167 Pretest – power	**168** 0.006
169 Postest – power	
170 Pretest – Agility	**171** 0.001
172 Postest – Agility	
173 Pretest – Endurance	**174** 0.001
175 Postest – Endurance	

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

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

178 Group	**179 Variable**	**180 Mean**	**181 Asymp. sig (2-tailed)**

182	Experiment	**183**	Power	**184**	50.53	**185**	0.416
186	Control			**187**	49.13		
188	Experiment	**189**	Agility	**190**	17.12	**191**	0.000
192	Control			**193**	17.65		
194	Experiment	**195**		**197**	50.32	**198**	0.000
199	Control	**196**	Endurance	**200**	43.71		

201 The findings of the Mann-Whitney analysis are shown in Table 4. 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.

202 Discussion

a. 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.

b. 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.

203 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.

204 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).

205 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)

206 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).

207 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).

208 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).

209 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 (Bachle & 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)

210 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 (Malina, 1998; Roemmich & Rogol, 1995).

211 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.

212 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 physical exercise to a drug, and the dose must be regulated and adjusted effectively (Gronwald et al, 2020).

213 Conclusions

214 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.

215 Acknowledgment

216 The author would like to thank the Semarang State University, Faculty of Sports Science, for their assistance in completing this research appropriately. Furthermore, the authors would like to thank the team for assisting in the collection of research data, which allowed this study to proceed successfully.

217 Conflict of interest

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

219 References

220 Akaruk, H. U. M., Inchester, J. A. B. W., Adowski, J. E. S., & Zaplicki, A. D. A. M. C. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *The Journal of Strength & Conditioning Research*, *25*(12), 3311-3318.

221 Alsaudi, A. T. B. D. (2020). The Influence of Drill Exercise and Eye Coordination Foot Methods Toward the Smash Skill of Badminton. In *1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)* (pp. 76-82). Atlantis Press.

222 Alviana, S. I., Mintarto, E., & Hariyanto, A. (2020). The Effect of Exercise with Ladder Drill Slaloms and Carioca on Speed and Agility. *International Journal for Educational and Vocational Studies*, *2*(1), 103-108.

223 Baechle, T. R., & Earle, R. W. (Eds.). (2008). *Essentials of strength training and conditioning*. Human kinetics.

224 Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Human Kinetics.

225 Bloshchynsky, I., Kovalchuk, R., Balendr, A., Aloshyna, A., Bahas, O., Mozolev, O & Prontenko, V. (2019). The conceptual basis of the organization of volleyball team training.

226 Boichuk, R., Iermakov, S., & Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage JPES ®. *Journal of Physical Education and Sport*, *17*(1), 327–334. https://doi.org/10.7752/jpes.2017.01048

227 Booth, M. A., & Orr, R. (2016). Effects of Plyometric Training on Sports Performance. *Strength & Conditioning Journal*, *38*(1), 30-37.

228 Bompa, T. O., & Buzzichelli, C. (2019). *Periodization-: theory and methodology of training*. Human kinetics.

229 Brendan, J., Tompsett, C., Burkett, B., & Mckean, M. R. (2014). Development of physical literacy and movement competency: A literature review. *Journal of fitness research*, *3*(2), 53-74.

230 Budiman, I. A. (2016). Development model of volleyball spike training. *International Journal of Sports Physical Education, Sport, and Health*, *3*(3), 466–471.

231 Buśko, K., Michalski, R., Mazur, J., & Gajewski, J. (2012). Jumping abilities in elite female volleyball players: Comparative analysis among age categories. *Biology of Sport*, *29*(4), 317-319.

232 Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches

of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching*, *11*(3), 410-421.

233 Davies, G. (2015). Current concepts of plyometrics exercise. *The International Journal of Sports Physical Therapy*, *10*(6), 760–786.

234 Diallo, O., Dore, E., Duche, P., & Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training program on physical performance in prepubescent soccer players. *Journal of sports medicine and physical fitness*, *41*(3), 342.

235 Duan, C. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal*, *60*(5), 4299-4306.

236 Edoya, A. A., Miltenberger, M. R., & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: a systematic review. *The Journal of Strength & Conditioning Research*, *29*(8), 2351-2360.

237 Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *British journal of sports medicine*, *50*(1), 3-7.

238 Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *The Journal of Strength & Conditioning Research*, *23*, S60-S79.

239 Fathi, A., Hammami, R., Moran, J., Borji, R., Sahli, S., & Rebai, H. (2019). Effect of a 16-week combined strength and plyometric training program followed by a detraining period on athletic performance in pubertal volleyball players. *The Journal of Strength & Conditioning Research*, *33*(8), 2117-2127.

240 Franchini, E., Nunes, A. V., Moraes, J. M., & Del Vecchio, F. B. (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of physiological anthropology*, *26*(2), 59-67.

241 Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *Journal of sports science & medicine*, *16*(4), 527.

242 Gronwald, T., Törpel, A., Herold, F., & Budde, H. (2020). Perspective of dose and response for individualized physical exercise and training prescription. *Journal of Functional Morphology and Kinesiology*, 5(3), 48.

243 https://doi.org/10.3390/jfmk5030048

244 Ichailidis, Y. I. M., Fatouros, I. G., Primpa, E., Michailidis, C., Avloniti, A., Chatzinikolaou, A., & Kambas, A. (2013). Plyometrics' trainability in preadolescent soccer athletes. *The Journal of Strength & Conditioning Research*, *27*(1), 38-49.

245 Idrizovic, K., Gjinovci, B., Sekulic, D., Uljevic, O., João, P. V., Spasic, M., & Sattler, T. (2018). The effects of 3-month skill-based and plyometric conditioning on fitness parameters in junior female volleyball players. *Pediatric exercise science*, *30*(3), 353-363.

246 Ingle, L., Sleap, M., & Tolfrey, K. (2006). The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of sports sciences*, *24*(9), 987-997.

247 Jastrzbeski, Z., Wnorowski, K., Mikolajewski, R., Jaskulska, E., & Radziminski, L. (2014). The effect of a 6-week plyometric training on explosive power in volleyball players. *Baltic Journal of Health and Physical Activity*, *6*(2), 1.

248 Jones, N. B., & Ledford, E. (2012). Strength and conditioning for Brazilian jiu-jitsu. *Strength & Conditioning Journal*, *34*(2), 60-69.

249 Kolev, P. (2020). Research of adolesencent volleyball palayers intrinsic motivation for achievement of high sports results. *Research in Kinesiology*, *48*.

250 Malina, R. M. (1998). Growth and maturation of young athletes: Is training for sport a factor. *Sports and children*, 133-161.

251 Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical

review. *British journal of sports medicine*, *41*(6), 349-355.

252 Markovic, G., Arkovic, G. O. M., Ukic, I. G. O. R. J., & Ilanovic, D. R. M. (2007). Effects of sprint and plyometrics training on muscle function and athletic performance. *Journal of Strength and Conditioning Research*, *21*(2), 543–549. https://doi.org/10.1519/R-19535.1

253 Markovic, G., & Mikulic, P. (2010). Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine*, *40*(10), 859-895.

254 Martínez-lópez, E. J., Benito-martínez, E., Hita-contreras, F., Lara-sánchez, A., & Martínez-amat, A. (2012). *Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes*. *August*, 727–735.

255 Maćkała, K., Synówka, A., Ćorluka, M., & Vodicar, J. (2021). Impact of Plyometric Training on the Power of Lower Limbs in Moderately Advanced Female Volleyball Players. *Acta Kinesiologica*, *15*(1), 5-12.

256 Medeni, Ö. Ç., Turgut, E., Çolakoğlu, F. F., & Baltacı, G. (2019). Plyometric training combined with jump rope training in female adolescent volleyball players. *Türkiye Klinikleri Sağlık Bilimleri Dergisi*, *4*(3), 261-268.

257 Meszler, B. (2019). European Journal of Integrative Medicine Combined strength and plyometric exercise training improves running economy and muscle elastic energy storage and re-use in young untrained women. *European Journal of Integrative Medicine*, *28*(November 2018), 86–91. https://doi.org/10.1016/j.eujim.2019.05.004

258 Meylan, C., & Malatesta, & D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *The Journal of Strength & Conditioning Research*, *23*(9), 2605-2613.

259 Milroy, T. (2010). Correlation between an Athletes' Consideration of Future Consequences and Their Improvement in Strength, Speed, and Agility with a Six Week Training Program. *Unpublished Master's Thesis). Bozeman, Montana: Montana State University*.

260 Negra, Y., Chaabene, H., Stöggl, T., Hammami, M., Chelly, M. S., & Hachana, Y. (2020). Effectiveness and time-course adaptation of resistance training vs. plyometric training in prepubertal soccer players. *Journal of Sport and Health Science*, *9*(6), 620-627.

261 Ng, R. S., Cheung, C. W., & Raymond, K. S. (2017). Effects of 6-week agility ladder drills during recess intervention on dynamic balance performance. *Journal of Physical Education and Sport*, *17*(1), 306.

262 Padrón-Cabo, A., Lorenzo-Martínez, M., Pérez-Ferreirós, A., Costa, P. B., & Rey, E. (2021). Effects of plyometric training with agility ladder on physical fitness in youth soccer players. *International Journal of Sports Medicine*, *42*(10), 896-904.

263 Pratama, N. E., Mintarto, E., Kusnanik, N. W., & Pratama, N. (2018). The influence of ladder drills and jump rope exercise towards speed, agility, and power of limb muscle. *Journal of Sports and Physical Education*, *5*(1), 22-29.

264 Potdevin, F. J., Alberty, M. E., Chevutschi, A., Pelayo, P., & Sidney, M. C. (2011). Effects of a 6-week plyometric training program on performances in pubescent swimmers. *The Journal of Strength & Conditioning Research*, *25*(1), 80-86.

265 Radcliffe, J., & Farentinos, R. (2015). *High-Powered Plyometrics, 2E*. Human kinetics.

266 Rahmi, S., & Bachtiar, I. (2020). The Contribution the Physical Condition on Underhand Serve Ability in Volleyball of Elementary School Students in Makassar City. In *3rd International Conference on Education, Science, and Technology (ICEST 2019)* (pp. 296-299). Atlantis Press.

267 Robin, K. V., & Raj, Y. L. (2019). Impact of ladder training on the agility performance of footballers. *International Journal of Yogic, Human Movement and Sports Sciences*, *4*(1), 1.

268 Roemmich, J. N., & Rogol, A. D. (1995). Physiology of growth and development: its relationship to performance in the young athlete. *Clinics in sports medicine*, *14*(3), 483-502.

269 Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research*, *25*(1), 129-134.

270 Suh, Y. I., Kim, J., Lee, S., Han, S., & Park, S. H. (2022). A qualitative investigation of leisure benefits for social and psychological health among international volleyball players living in South Korea. *International Journal of Qualitative Studies on Health and Well-being*, *17*(1), 2131216.

271 Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Teorìâ ta Metodika Fìzičnogo Vihovannâ*, *21*(2), 173-179.

272 Taware, G. B., Bhutkar, M. V., & Surdi, A. D. (2013). A profile of fitness parameters and performance of volleyball players. *Journal of Krishna Institute of Medical Sciences University*, *2*(2), 48-59.

273 Vassil, K., & Bazanovk, B. (2012). The effect of plyometric training program on young volleyball players in their usual training period. *Journal of Human Sport and Exercise*, *7*(1), S34-S40.

274 Wang, Y., & Zhang, N. A. (2016). Effects of plyometric training on soccer players. *Experimental and therapeutic medicine*, *12*(2), 550-554.

275 Watkins, C. M., Gill, N. D., Maunder, E., Downes, P., Young, J. D., McGuigan, M. R., & Storey, A. G. (2021). The Effect of Low-Volume Preseason Plyometric Training on Force-Velocity Profiles in Semiprofessional Rugby Union Players. *The Journal of Strength & Conditioning Research*, *35*(3), 604-615.

276 Weber, M. L., Lam, K. C., & McLeod, T. C. V. (2016). The effectiveness of injury prevention programs for youth and adolescent athletes. *International Journal of Athletic Therapy and Training*, *21*(2), 25-31.

277 Wicaksono, D., Hidayatullah, F., Kristiyanto, A., & Purnama, S. K. (2022). The Effect of Training Based on Part And Whole Combinations on Smash Techniques Improvement in Volleyball Sports for 11-12 Year Old Athletes. *Teorìâ Ta Metodika Fìzičnogo Vihovannâ*, *22*(1), 62-69.

278 Young, M. E. M., Goslin, A., Potgieter, N., Nthangeni, S., & Modise, J. (2011). Sport and recreation participation preferences in the Botswana Defence Force: sport and recreation participation. *African Journal for Physical Health Education, Recreation and Dance*, *17*(sup-1), 134-145.

279 Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences*, *9*(5), 1051–1057. https://doi.org/10.13189/saj.2021.090527

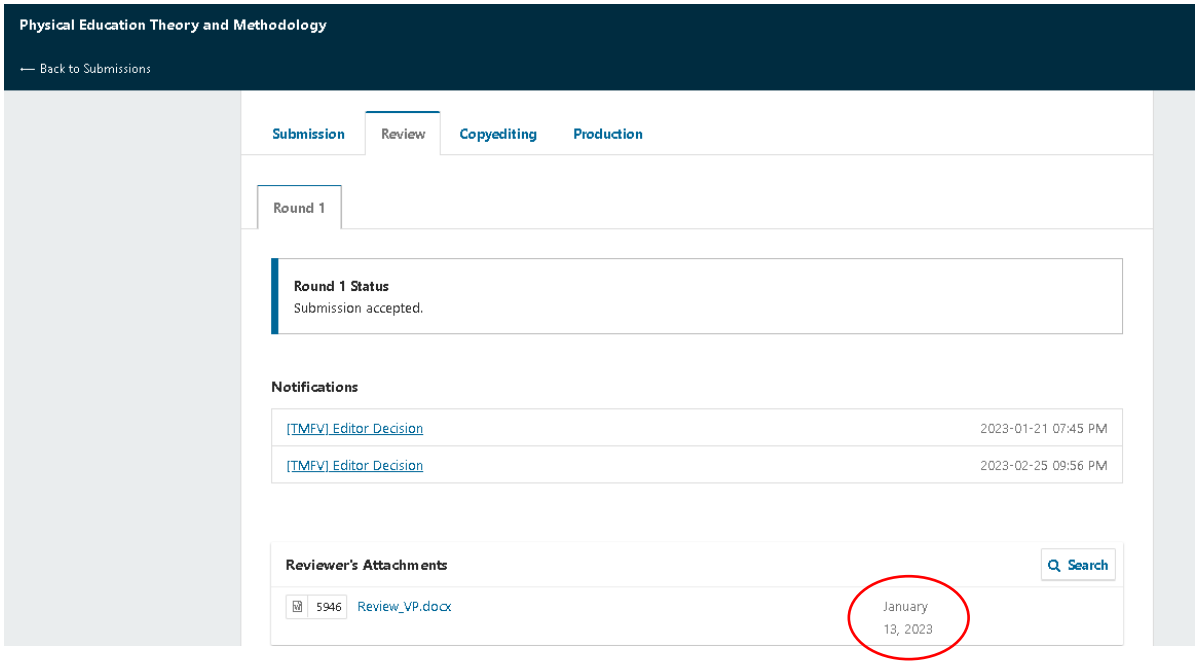
280 Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences*, *8*(5), 211–216. https://doi.org/10.13189/saj.2020.080508

281 Yulianto, W. D., & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science*, *9*(3), 60-65.

282 Zech, A., Hollander, K., Junge, A., Steib, S., Groll, A., Heiner, J., ... & Rahlf, A. L. (2021). Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. *Journal of sport and health science*.

283 Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. *Scandinavian journal of medicine & science in sports*, *20*(4), 556-567.

Artikel dikirimkan Editor masuk dalam proses Review dan mendapatkan catatan dari reviewer [13 Januari 2023]



Review

The peer-reviewed article contains some controversial points that need clarification:

53 (Buko et al, 2012)

(Buśko et al, 2012)?

70-71 advantages for boosting power, agility, coordination, flexibility, and endurance (Pratama et al, 2018).

the terms «agility» and «coordination» have close meanings. In our opinion, it is better to use the term «agility» when referring to game sports

97 Makaa et al (2021)

Maćkała, K. et al (2021)?

101-102 Country et al, 2020;?

The link is missing in «References»

113 height of ±157-170 cm and a body weight of ±57-67 kilograms.

height of 157-170 cm and a body weight of 57-67 kilograms?

154-174 The name of table 3 «The results of the pretest-posttest comparison of the experimental group based on Wilcoxon analysis» partially corresponds to the text part (166-174)

172-174 As a result, the results revealed a substantial difference between the pretest and posttest outcomes of aerobic endurance.

I offer textual correction of the sentence (the term «result»)

178-179 The name of table 4 «Table 4. The results of the post-test comparison of the experimental and control groups based on Mann Whitney analysis» partially corresponds to the text part (*indicators of strength, dexterity, endurance*)

248-256 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).

It is desirable to clarify the specifics of building a plyometric training program for young volleyball players aged 13-15, as mistakes can lead to overloading of the musculoskeletal system and the occurrence of Osgood-Schlatter disease (10-19 age)

271-274 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 (Malina, 1998; Roemmich & Rogol, 1995).

In our opinion, it is desirable to update references to literature sources (1995 and 1998)

286-288 The success of an exercise is an individual loading adjustment and regular exercise dosage; we compare physical exercise to a drug, and the dose must be regulated and adjusted effectively (Gronwald et al, 2020).

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).

193-288 *To the "Discussion" section, it is desirable to add materials that relate to completely new data obtained as a result of research and data that complement or expand existing scientific knowledge*

321-322 Balyi, I., Way, R., & Higgs, C. (2013). Long-term athlete development. Human Kinetics.

References to literature sources must be made according to the requirements.

453-454 Radcliffe, J., & Farentinos, R. (2015). High-Powered Plyometrics, 2E. Human kinetics.

References to literature sources must be made according to the requirements.

Out of 63 references to literature sources – 28 are analyzed in the «Introduction» (25-107): 1 source is not displayed in the reference.

2 sources of literature (total number - 63) are analyzed in the introduction and in the discussion:

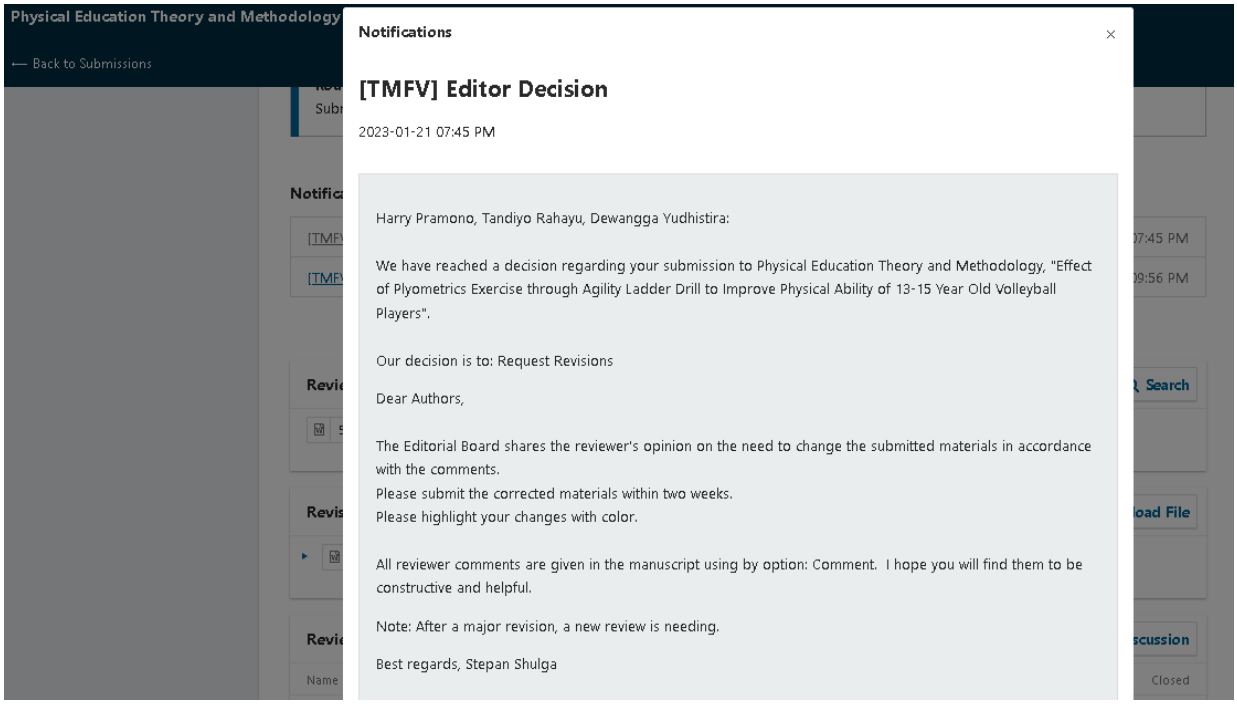
(Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. British journal of sports medicine, 50(1), 3-7.

Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. The Journal of Strength & Conditioning Research, 25(1), 129-134.)

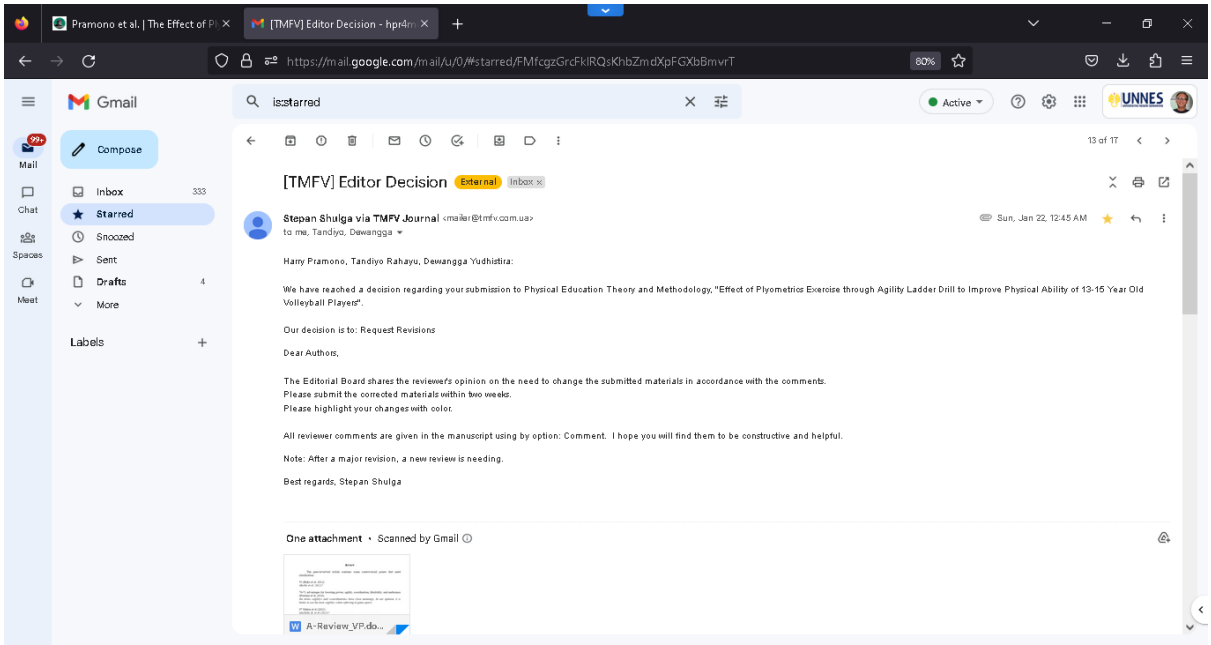
This can be interpreted as a rather weak connection between the parts of the research work

Sincerely, Reviewer

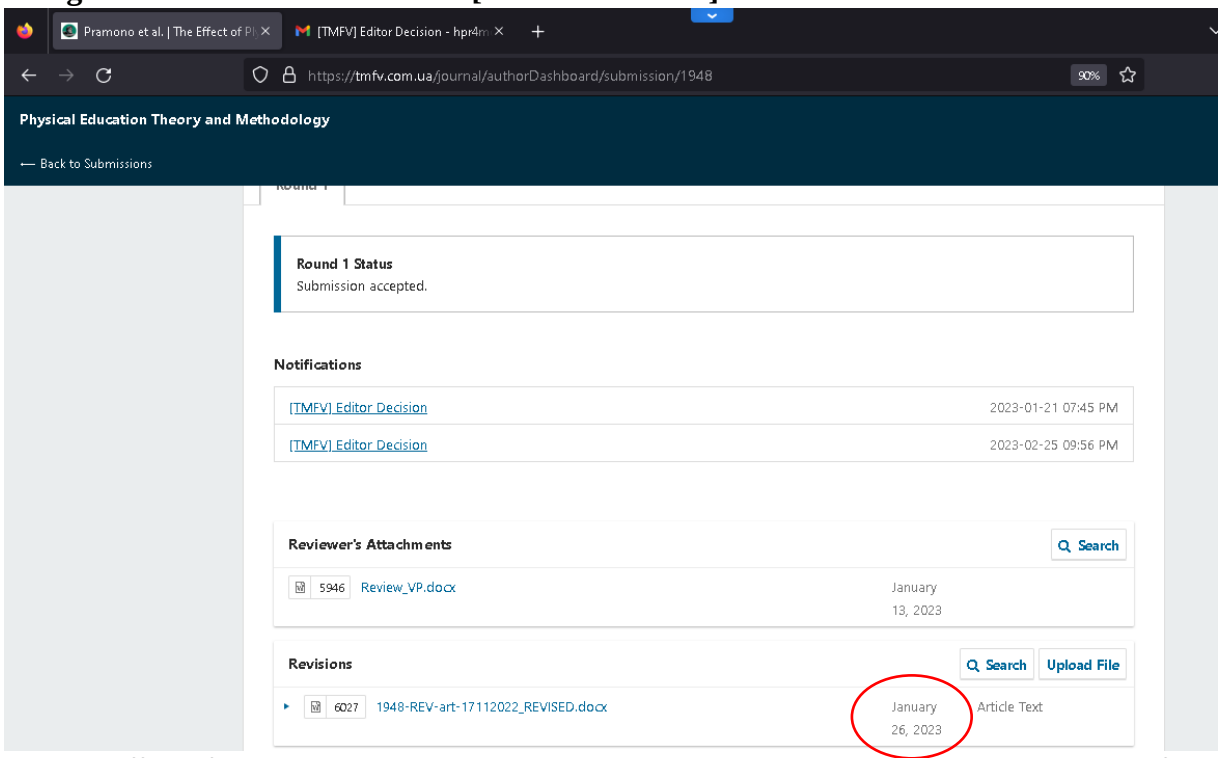
Mendapatkan Notifikasi/pemberitahuan oleh Editor adanya revisi Artikel melalui OJS [21 Januari 2023]



Mendapatkan Notifikasi/pemberitahuan adanya revisi Artikel melalui E-mail [22 Januari 2023]



Mengirimkan hasil Revisi ke OJS [26 Januari 2023]



1 **The Effect of Plyometrics Exercise through Agility Ladder Drill to Improve Physical Ability of 13-15 Year Old Volleyball Players**

2 Abstract

3 **Objectives.** 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 0.001<0.05, and endurance 0.001<0.05. In the Mann-Whitney test, the value of Asymp. sig(2-tailed) was 0.416>0.05, agility 0.00<0.05, endurance, 0.00<0.05. **Conclusion**: 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.

4 **Keywords: Plyometrics, agility ladder drill, young volleyball players**

5 **Introduction**

6 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).

7 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).

8 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.

9 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)

10 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 (Buśko et al, 2012). In-depth research, however, is required in the application of physical training for volleyball players aged 13 to 15.

11 A coach's responsibility is to establish an adequate training program for the chronological ages of young athletes(Wicaksono & Hidayatullah, 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 (Sulistiyono et al, 2021). As a result, the purpose of a long-term training program is to build, maximize, and sustain peak performance.

12 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).

13 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)

a. 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 (Rubley et al, 2011).

14 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 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:

22*Table 1.* *Plyometrics agility ladder drill training program*

23*Week*	**24*Meeting***	**25*Exercise Items***	**26*Exercise Dosage***
27	**29**	**31***Item 1: Rabbit hops* **32***Item 2: Straddle hops squat*	**34***Volume (rep x sets) : 6 x 3 on one exercise item*
	30*1-3*	**33***Item 3: Hopscotch*	**35***Rest between reps: 10-15 seconds* **36***Rest between sets: 60 seconds* **37***Intensity: moderate – maximal*
28*1-2*			
	38	**40***Item 1: Ladder taps (left leg)* **41***Item 2: Ladder taps (right leg)* **42***Item 3: Single leg hops (left leg)* **43***Item 4: Single leg hops (right leg)*	**44***Volume (rep x sets) : 10 x 3 on one exercise item* **45***Rest between reps: 10-15 seconds* **46***Rest between sets: 60 seconds* **47***Intensity: moderate – maximal*
	39*4-6*		
48	**50**	**52***Item 1: Shuffle* **53***Item 2: Snake Jump* **54***Item 3: Straddle hops* **55***Item 4: Skiers jump*	**56***Volume (rep x set) : 10 x 4 on one exercise item* **57***Rest between reps: 10-15 seconds* **58***Rest between sets: 60 seconds* **59***Intensity: moderate – maximal*
	51*7-9*		
49*3-4*			
	60	**62***Item 1: Two-foot hoops – zigzag pattern* **63***Item 2: Single foot hops zig-zag pattern (left right* **64***Item 3: Single foot hops zig-zag pattern (right leg)*	**65***Volume (rep x set) : 15 x 2 on one exercise item* **66***Rest between reps: 10-15 seconds* **67***Rest between sets: 60 seconds* **68***Intensity: moderate – maximal*
	61*10-12*		

69	**71**	**73***Item 1: Forward-backward hop* **74***Item 2: Cross legs* **75***Item 3: Fight shuffle* **76***Item 4: Two forward, one back*	**77***Volume (rep x set) : 10 x 4 on one exercise item* **78***Rest between reps: 10-15 seconds* **79***Rest between sets: 60 seconds* **80***Intensity: moderate – maximal*
	72*13-15*		
70*5-6*			
	81	**83***Item 5: Lateral in out* **84***Item 6: Carioca* **85***Item 7: Ski jumps*	**86***Volume (rep x set) : 15 x 3 on one exercise item* **87***Rest between reps: 10-15 seconds* **88***Rest between sets: 60 seconds* **89***Intensity: moderate – maximal*
	82*16-18*		

90*Statistical analysis.*

91The SPSS version 23 program was used to process the data. The first analysis was a descriptive analysis in which the 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.

92Table 2. Descriptive analysis results of pretest and posttest power agility and endurance

93Group	**94Variable**	**95Pretest**				
97		**99**Min	**100** Max	**101** Mean	**102** SD	**10**
98Experiment	**107** Power	**108** 41	**109** 56	**110** 49.73	**111** 4.803	**1**
	116 Agility	**117** 17.12	**118** 18.34	**119** 17.61	**120** .47211	**12**
	125 Endurance	**126** 38.09	**127** 48.08	**128** 44.69	**129** 3.24535	**13**

134	136	Power	137	42	138	56	139	49.27	140	4.511
135 Control	145	Agility	146	17.09	147	18.23	148	17.65	149	.40813
	154	Endurance	155	38.10	156	48.08	157	43.91	158	2.76913

163 Results

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

165 Variable	166 Asymp. sig (2-tailed)
167 Pretest – power	168 0.006
169 Postest – power	
170 Pretest – Agility	171 0.001
172 Postest – Agility	
173 Pretest – Endurance	174 0.001
175 Postest – Endurance	

176 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 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.

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

178 Group	179 Variable	180 Mean	181 Asymp. sig (2-tailed)
182 Experiment	183 Power	184 50.53	185 0.416
186 Control		187 49.13	
188 Experiment	189 Agility	190 17.12	191 0.000
192 Control		193 17.65	
194 Experiment	195	197 50.32	198 0.000
199 Control	196 Endurance	200 43.71	

201 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.

202 Discussion

a. 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.
b. 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.

203 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.

204 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).

205 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)

206 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).

207 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).

208 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)

209 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 (Bachle & 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)

210 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)

211 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.

212 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).

213 Conclusions

214 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.

215 Acknowledgment

216 The author would like to thank the Semarang State University, Faculty of Sports Science, for their assistance in completing this research appropriately. Furthermore, the authors would like to thank the team for assisting in the collection of research data, which allowed this study to proceed successfully.

Conflict of interest

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

References

Akaruk, H. U. M., Inchester, J. A. B. W., Adowski, J. E. S., & Zaplicki, A. D. A. M. C. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *The Journal of Strength & Conditioning Research*, *25*(12), 3311-3318.

Alsaudi, A. T. B. D. (2020). The Influence of Drill Exercise and Eye Coordination Foot Methods Toward the Smash Skill of Badminton. In *1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)* (pp. 76-82). Atlantis Press.

Alviana, S. I., Mintarto, E., & Hariyanto, A. (2020). The Effect of Exercise with Ladder Drill Slaloms and Carioca on Speed and Agility. *International Journal for Educational and Vocational Studies*, *2*(1), 103-108.

Baechle, T. R., & Earle, R. W. (Eds.). (2008). *Essentials of strength training and conditioning*. Human kinetics.

Balyi, I., & Way, R. (2013). Long-term athlete development. In Choice Reviews Online, 51(09). https://doi.org/10.5860/choice.51-5081

Bloshchynsky, I., Kovalchuk, R., Balendr, A., Aloshyna, A., Bahas, O., Mozolev, O & Prontenko, V. (2019). The conceptual basis of the organization of volleyball team training.

Boichuk, R., Iermakov, S., & Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage JPES ®. *Journal of Physical Education and Sport*, *17*(1), 327–334. https://doi.org/10.7752/jpes.2017.01048

Booth, M. A., & Orr, R. (2016). Effects of Plyometric Training on Sports Performance. *Strength & Conditioning Journal*, *38*(1), 30-37.

Bompa, T. O., & Buzzichelli, C. (2019). *Periodization-: theory and methodology of training*. Human kinetics.

Brendan, J., Tompsett, C., Burkett, B., & Mckean, M. R. (2014). Development of physical literacy and movement competency: A literature review. *Journal of fitness research*, *3*(2), 53-74.

Budiman, I. A. (2016). Development model of volleyball spike training. *International Journal of Sports Physical Education, Sport, and Health*, *3*(3), 466–471.

Buśko, K., Michalski, R., Mazur, J., & Gajewski, J. (2012). Jumping abilities in elite female volleyball players: Comparative analysis among age categories. *Biology of Sport*, *29*(4), 317-319.

Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching*, *11*(3), 410-421.

Davies, G. (2015). Current concepts of plyometrics exercise. *The International Journal of Sports Physical Therapy*, *10*(6), 760–786.

Diallo, O., Dore, E., Duche, P., & Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training program on physical performance in prepubescent soccer players. *Journal of sports medicine and physical fitness*, *41*(3), 342.

Duan, C. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal*, *60*(5), 4299-4306.

Edoya, A. A., Miltenberger, M. R., & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: a systematic review. *The Journal of Strength & Conditioning Research*, *29*(8), 2351-2360.

Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *British journal of sports medicine*, *50*(1), 3-7.

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the

national strength and conditioning association. *The Journal of Strength & Conditioning Research*, *23*, S60-S79.

239 Fathi, A., Hammami, R., Moran, J., Borji, R., Sahli, S., & Rebai, H. (2019). Effect of a 16-week combined strength and plyometric training program followed by a detraining period on athletic performance in pubertal volleyball players. *The Journal of Strength & Conditioning Research*, *33*(8), 2117-2127.

240 Franchini, E., Nunes, A. V., Moraes, J. M., & Del Vecchio, F. B. (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of physiological anthropology*, *26*(2), 59-67.

241 Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *Journal of sports science & medicine*, *16*(4), 527.

242 Gronwald, T., Törpel, A., Herold, F., & Budde, H. (2020). Perspective of dose and response for individualized physical exercise and training prescription. *Journal of Functional Morphology and Kinesiology*, 5(3), 48. https://doi.org/10.3390/jfmk5030048

243 Ichailidis, Y. I. M., Fatouros, I. G., Primpa, E., Michailidis, C., Avloniti, A., Chatzinikolaou, A., & Kambas, A. (2013). Plyometrics' trainability in preadolescent soccer athletes. *The Journal of Strength & Conditioning Research*, *27*(1), 38-49.

244 Idrizovic, K., Gjinovci, B., Sekulic, D., Uljevic, O., João, P. V., Spasic, M., & Sattler, T. (2018). The effects of 3-month skill-based and plyometric conditioning on fitness parameters in junior female volleyball players. *Pediatric exercise science*, *30*(3), 353-363.

245 Ingle, L., Sleap, M., & Tolfrey, K. (2006). The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of sports sciences*, *24*(9), 987-997.

246 Jastrzbeski, Z., Wnorowski, K., Mikolajewski, R., Jaskulska, E., & Radziminski, L. (2014). The effect of a 6-week plyometric training on explosive power in volleyball players. *Baltic Journal of Health and Physical Activity*, *6*(2), 1.

247 Jones, N. B., & Ledford, E. (2012). Strength and conditioning for Brazilian jiu-jitsu. *Strength & Conditioning Journal*, *34*(2), 60-69.

248 Kolev, P. (2020). Research of adolesencent volleyball palayers intrinsic motivation for achievement of high sports results. *Research in Kinesiology*, *48*.

249 Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British journal of sports medicine*, *41*(6), 349-355.

250 Markovic, G., Arkovic, G. O. M., Ukic, I. G. O. R. J., & Ilanovic, D. R. M. (2007). Effects of sprint and plyometrics training on muscle function and athletic performance. *Journal of Strength and Conditioning Research*, *21*(2), 543–549. https://doi.org/10.1519/R-19535.1

251 Markovic, G., & Mikulic, P. (2010). Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine*, *40*(10), 859-895.

252 Martínez-lópez, E. J., Benito-martínez, E., Hita-contreras, F., Lara-sánchez, A., & Martínez-amat, A. (2012). *Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes*. *August*, 727–735.

253 Maćkała, K., Synówka, A., Ćorluka, M., & Vodicar, J. (2021). Impact of Plyometric Training on the Power of Lower Limbs in Moderately Advanced Female Volleyball Players. *Acta Kinesiologica*, *15*(1), 5-12.

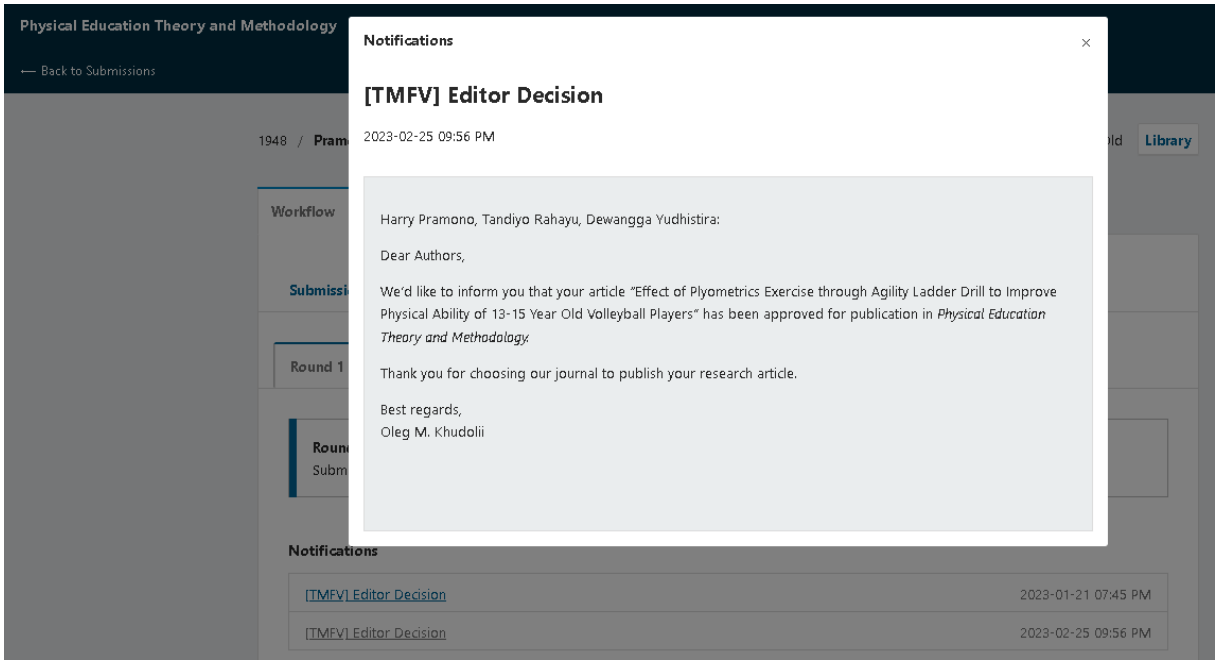
254 Medeni, Ö. Ç., Turgut, E., Çolakoğlu, F. F., & Baltacı, G. (2019). Plyometric training combined with jump rope training in female adolescent volleyball players. *Türkiye Klinikleri Sağlık Bilimleri Dergisi*, *4*(3), 261-268.

255 Meszler, B. (2019). European Journal of Integrative Medicine Combined strength and plyometric exercise training improves running economy and muscle elastic energy storage and re-use in young untrained women. *European Journal of Integrative Medicine*, *28*(November 2018), 86–91. https://doi.org/10.1016/j.eujim.2019.05.004

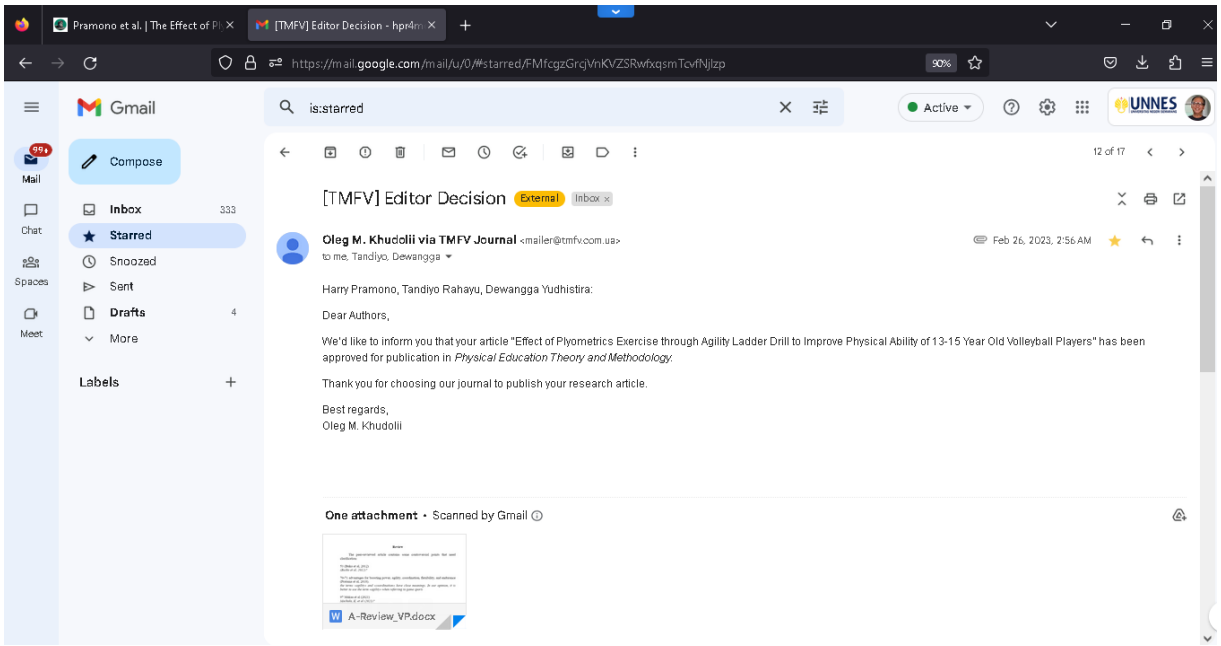
256 Meylan, C., & Malatesta, & D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *The Journal of Strength & Conditioning Research*, *23*(9), 2605-2613.
257 Milroy, T. (2010). Correlation between an Athletes' Consideration of Future Consequences and Their Improvement in Strength, Speed, and Agility with a Six Week Training Program. *Unpublished Master's Thesis). Bozeman, Montana: Montana State University*.
258 Myer, G. D., Lloyd, R. S., Brent, J. L., & Faigenbaum, A. D. (2013). How young is "too young" to start training?. *ACSM's health & fitness journal*, *17*(5), 14.
259 Negra, Y., Chaabene, H., Stöggl, T., Hammami, M., Chelly, M. S., & Hachana, Y. (2020). Effectiveness and time-course adaptation of resistance training vs. plyometric training in prepubertal soccer players. *Journal of Sport and Health Science*, *9*(6), 620-627.
260 Ng, R. S., Cheung, C. W., & Raymond, K. S. (2017). Effects of 6-week agility ladder drills during recess intervention on dynamic balance performance. *Journal of Physical Education and Sport*, *17*(1), 306.
261 Ozmen, T., & Aydogmus, M. (2017). Effect of plyometric training on jumping performance and agility in adolescent badminton players. *Turkish Journal of Sport and Exercise*, *19*(2), 222-227.
262 Padrón-Cabo, A., Lorenzo-Martínez, M., Pérez-Ferreirós, A., Costa, P. B., & Rey, E. (2021). Effects of plyometric training with agility ladder on physical fitness in youth soccer players. *International Journal of Sports Medicine*, *42*(10), 896-904.
263 Patel, S. H. (2002). A descriptive analysis of physical therapists' knowledge of pediatric sports injury diagnosis and management. D'Youville College.
264 Pratama, N. E., Mintarto, E., Kusnanik, N. W., & Pratama, N. (2018). The influence of ladder drills and jump rope exercise towards speed, agility, and power of limb muscle. *Journal of Sports and Physical Education*, *5*(1), 22-29.
265 Potdevin, F. J., Alberty, M. E., Chevutschi, A., Pelayo, P., & Sidney, M. C. (2011). Effects of a 6-week plyometric training program on performances in pubescent swimmers. *The Journal of Strength & Conditioning Research*, *25*(1), 80-86.
266 Radcliffe, J., & Farentinos, R. (2015). High-Powered plyometrics (2nd ed.). Human Kinetics
267 Rahmi, S., & Bachtiar, I. (2020). The Contribution the Physical Condition on Underhand Serve Ability in Volleyball of Elementary School Students in Makassar City. In *3rd International Conference on Education, Science, and Technology (ICEST 2019)* (pp. 296-299). Atlantis Press.
268 Ramirez-Campillo, R., Sanchez-Sanchez, J., Romero-Moraleda, B., Yanci, J., García-Hermoso, A., & Manuel Clemente, F. (2020). Effects of plyometric jump training in female soccer player's vertical jump height: A systematic review with meta-analysis. *Journal of Sports Sciences*, *38*(13), 1475-1487.
269 Robin, K. V., & Raj, Y. L. (2019). Impact of ladder training on the agility performance of footballers. *International Journal of Yogic, Human Movement and Sports Sciences*, *4*(1), 1.
270 Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research*, *25*(1), 129-134.
271 Suh, Y. I., Kim, J., Lee, S., Han, S., & Park, S. H. (2022). A qualitative investigation of leisure benefits for social and psychological health among international volleyball players living in South Korea. *International Journal of Qualitative Studies on Health and Well-being*, *17*(1), 2131216.
272 Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Teorìâ ta Metodika Fìzičnogo Vihovannâ*, *21*(2), 173-179.
273 Taware, G. B., Bhutkar, M. V., & Surdi, A. D. (2013). A profile of fitness parameters and performance of volleyball players. *Journal of Krishna Institute of Medical Sciences University*, *2*(2), 48-59.

274 Vassil, K., & Bazanovk, B. (2012). The effect of plyometric training program on young volleyball players in their usual training period. *Journal of Human Sport and Exercise*, *7*(1), S34-S40.
275 Wang, Y., & Zhang, N. A. (2016). Effects of plyometric training on soccer players. *Experimental and therapeutic medicine*, *12*(2), 550-554.
276 Watkins, C. M., Gill, N. D., Maunder, E., Downes, P., Young, J. D., McGuigan, M. R., & Storey, A. G. (2021). The Effect of Low-Volume Preseason Plyometric Training on Force-Velocity Profiles in Semiprofessional Rugby Union Players. *The Journal of Strength & Conditioning Research*, *35*(3), 604-615.
277 Weber, M. L., Lam, K. C., & McLeod, T. C. V. (2016). The effectiveness of injury prevention programs for youth and adolescent athletes. *International Journal of Athletic Therapy and Training*, *21*(2), 25-31.
278 Wicaksono, D., Hidayatullah, F., Kristiyanto, A., & Purnama, S. K. (2022). The Effect of Training Based on Part And Whole Combinations on Smash Techniques Improvement in Volleyball Sports for 11-12 Year Old Athletes. *Teorìâ Ta Metodika Fìzičnogo Vihovannâ*, *22*(1), 62-69.
279 Young, M. E. M., Goslin, A., Potgieter, N., Nthangeni, S., & Modise, J. (2011). Sport and recreation participation preferences in the Botswana Defence Force: sport and recreation participation. *African Journal for Physical Health Education, Recreation and Dance*, *17*(sup-1), 134-145.
280 Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences*, *9*(5), 1051–1057. https://doi.org/10.13189/saj.2021.090527
281 Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences*, *8*(5), 211–216. https://doi.org/10.13189/saj.2020.080508
282 Yulianto, W. D., & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science*, *9*(3), 60-65.
283 Zech, A., Hollander, K., Junge, A., Steib, S., Groll, A., Heiner, J., ... & Rahlf, A. L. (2021). Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. *Journal of sport and health science*.
284 Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. *Scandinavian journal of medicine & science in sports*, *20*(4), 556-567.

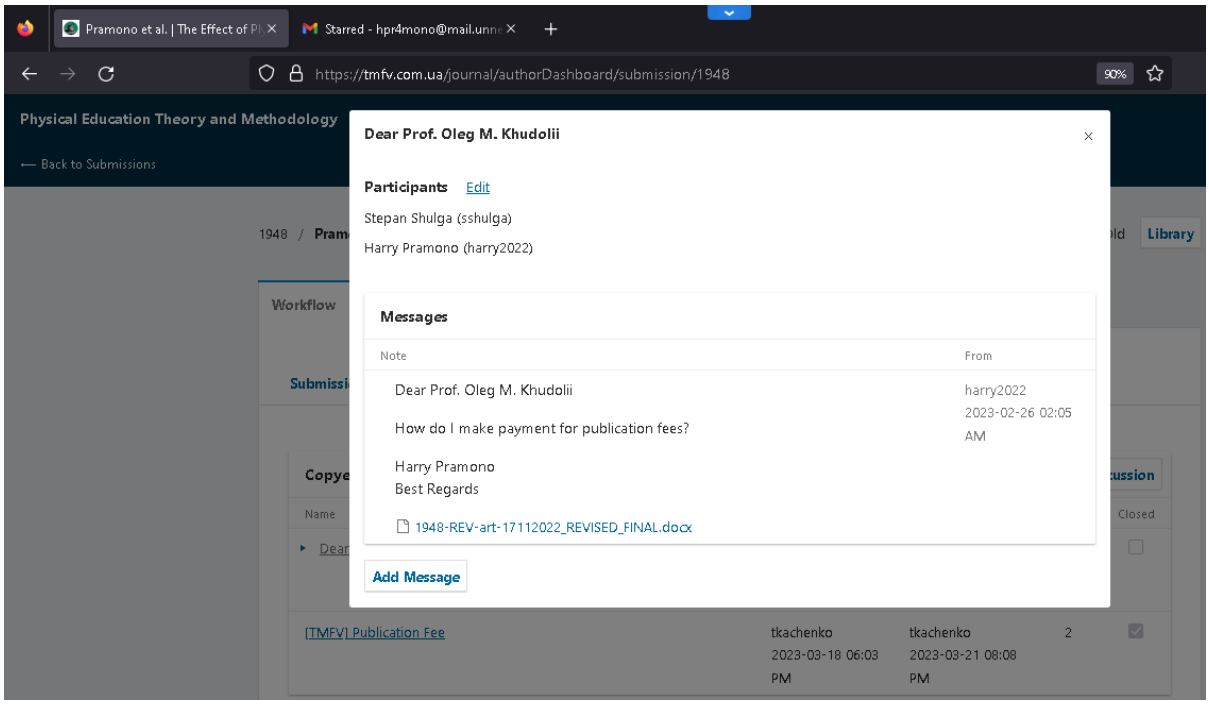
Mendapatkan Notifikasi/pemberitahuan oleh Editor bahwa revisi telah diterima melalui OJS [25 Februari 2023]



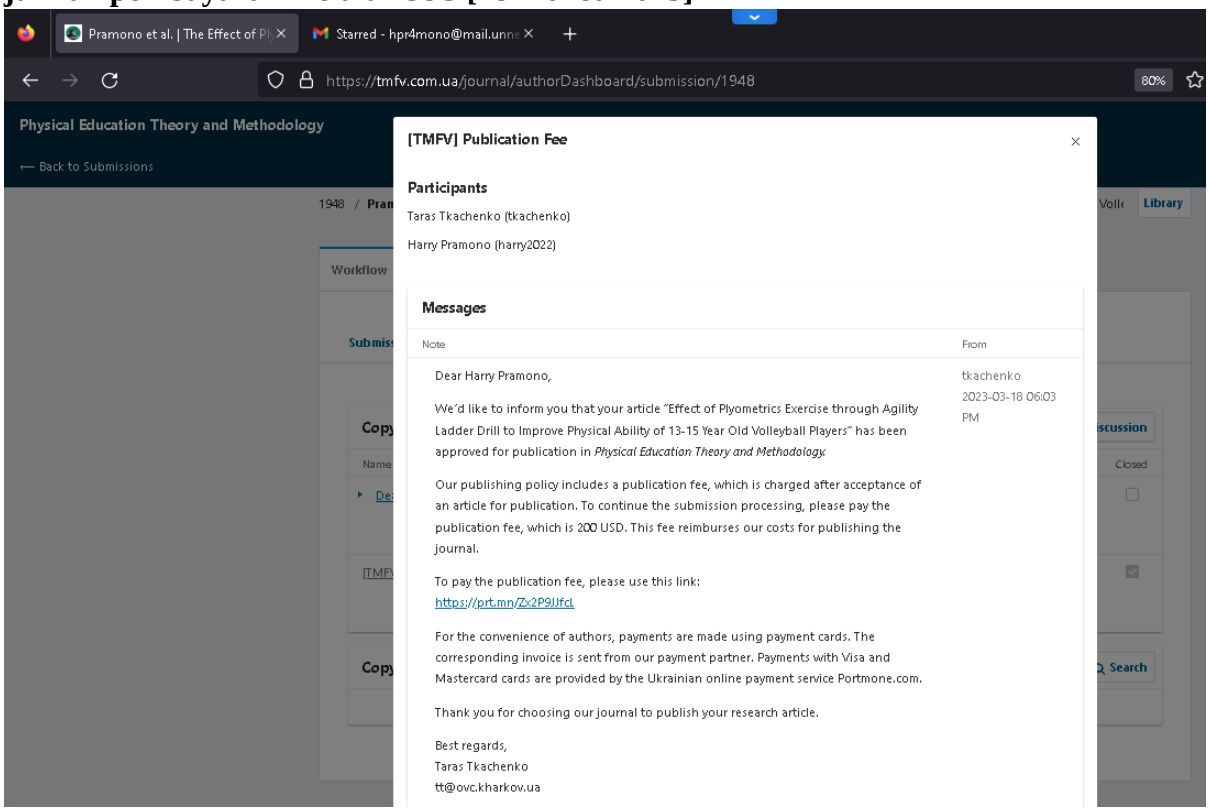
Mendapatkan Notifikasi/pemberitahuan oleh Editor bahwa revisi telah diterima melalui e-mail [26 Februari 2023]



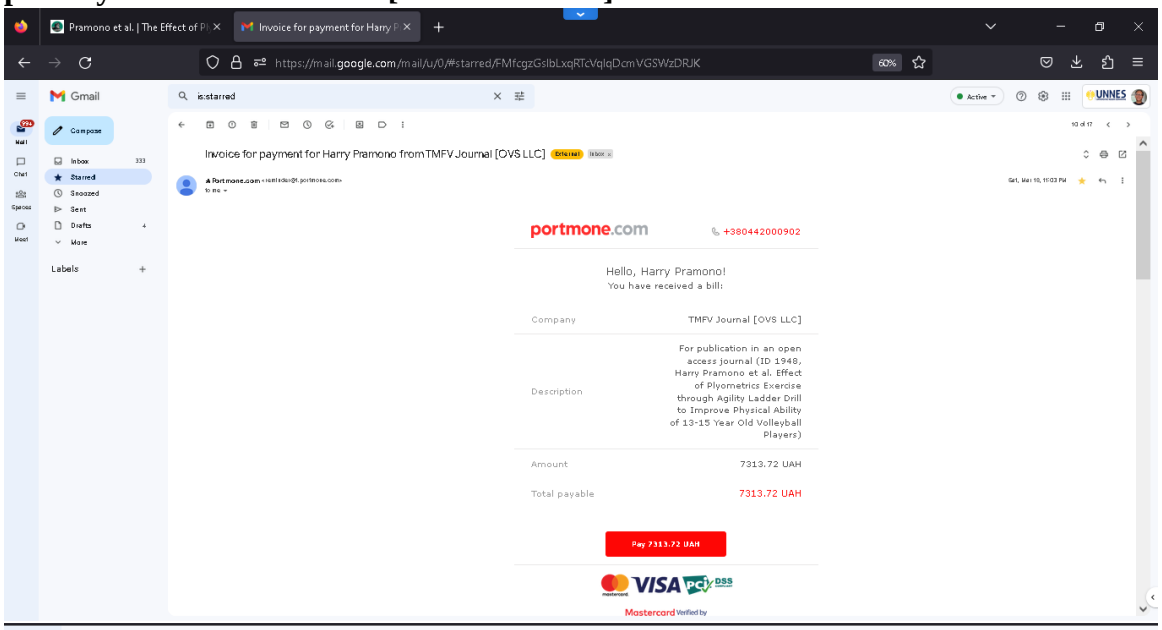
Mendapatkan Notifikasi/pemberitahuan oleh Editor terkait pembayaran yang akan dilakukan melalui OJS dan diterimanya artikel hasil revisi yang akan publish [26 Februari 2023]

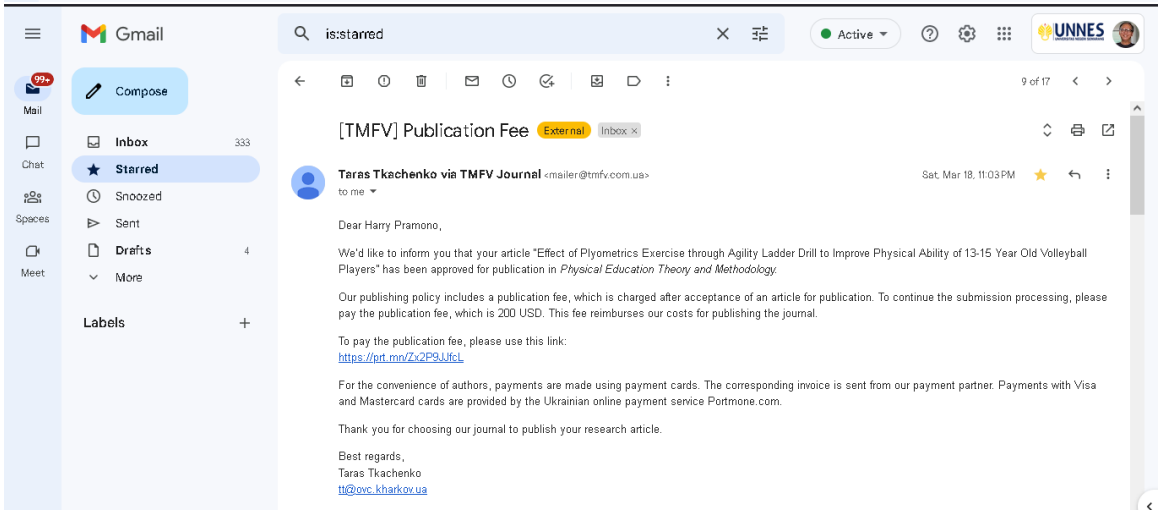


Mendapatkan Notifikasi/pemberitahuan oleh Editor terkait cara pembayaran dan jumlah pembayaran melalui OJS [18 Maret 2023]



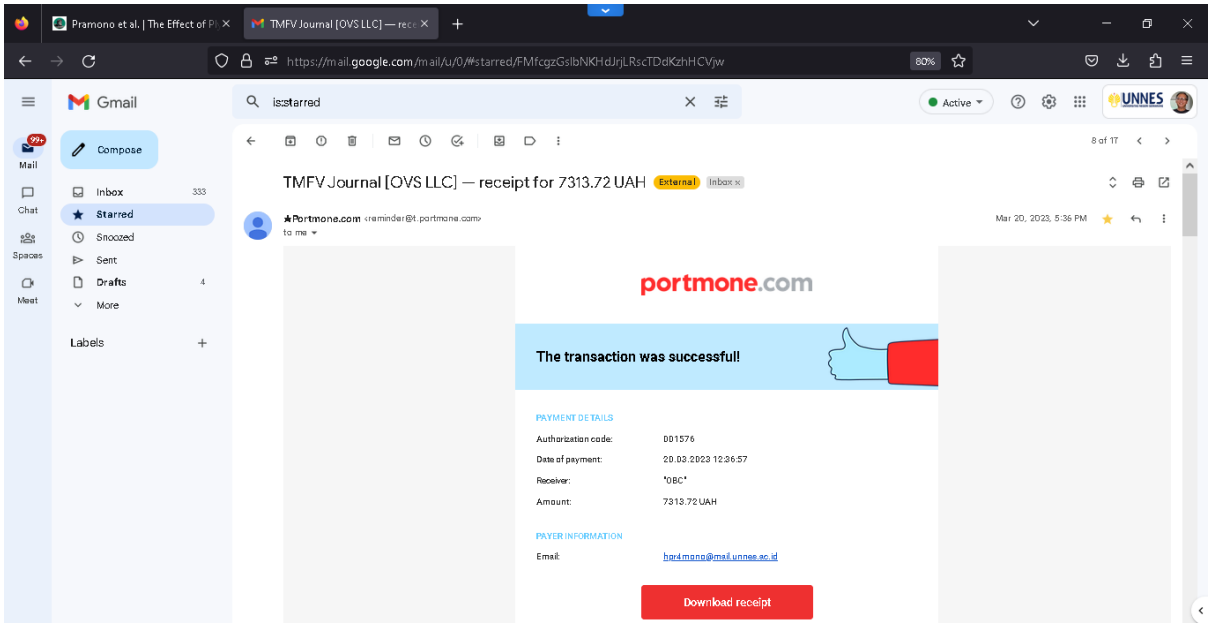
Mendapatkan Notifikasi/pemberitahuan terkait cara pembayaran dan jumlah pembayaran melalui e-mail [18 Maret 2023]



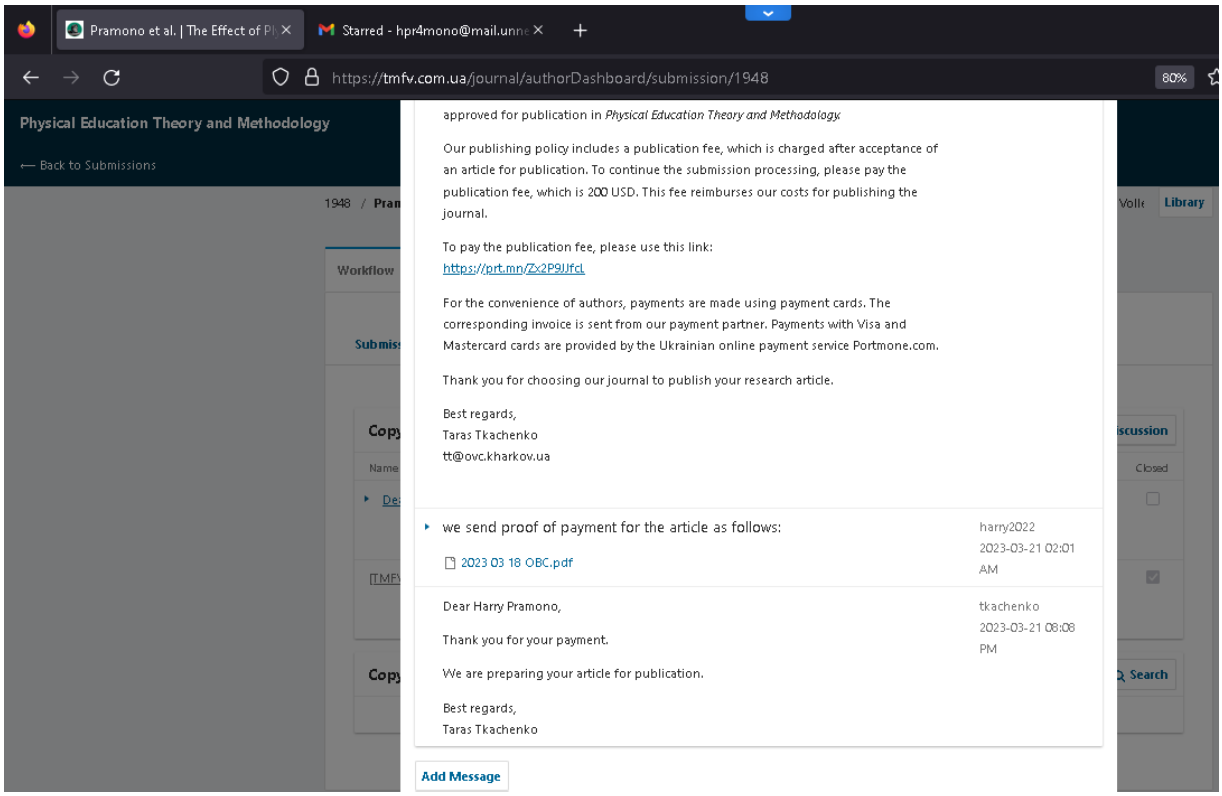


Melakukan pembayaran fee dan mendapatkan invoice dari untuk publish [20 Maret 2023]

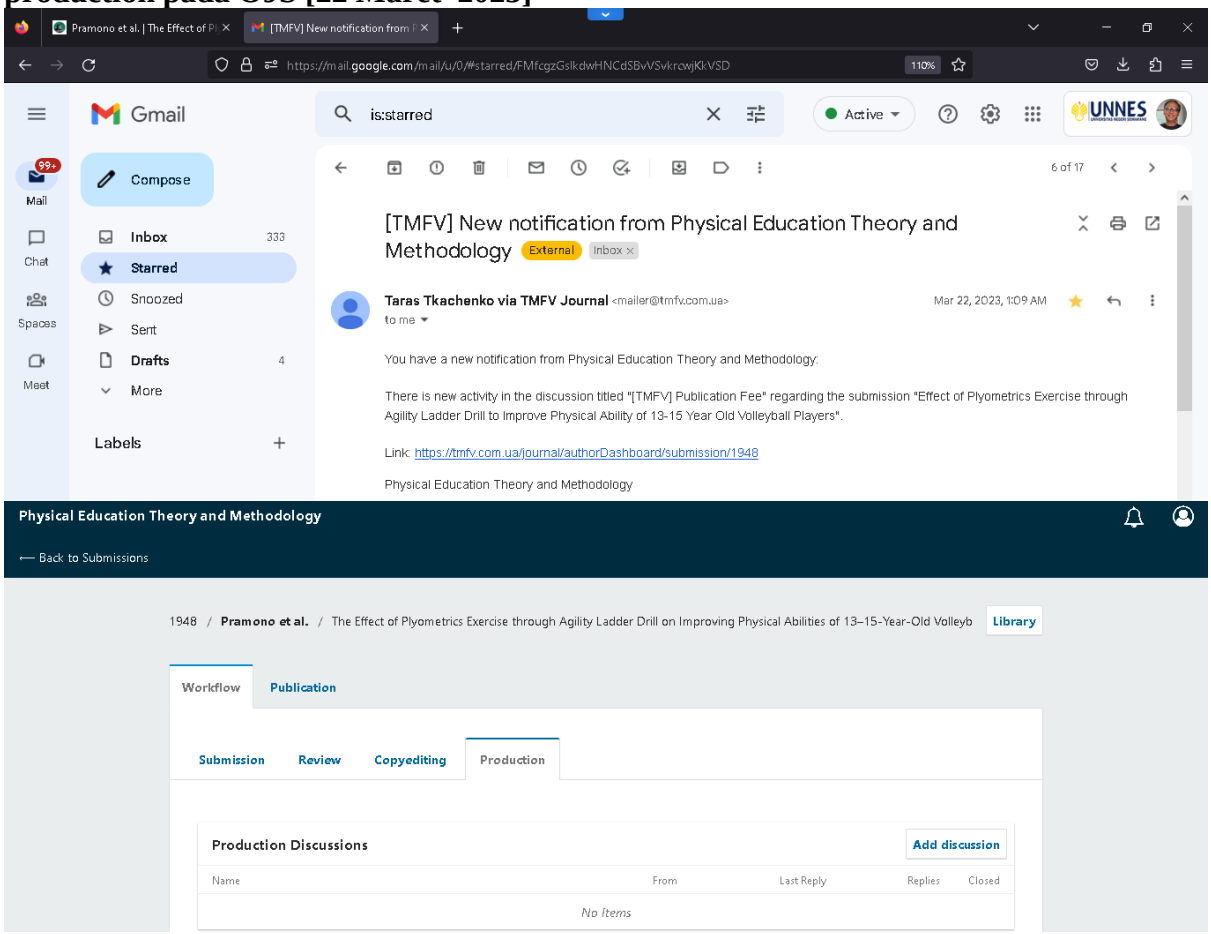
Mendapatkan balasan bahwa pembayaran fee sudah diterima melalui e-mail [20 Maret 2023]



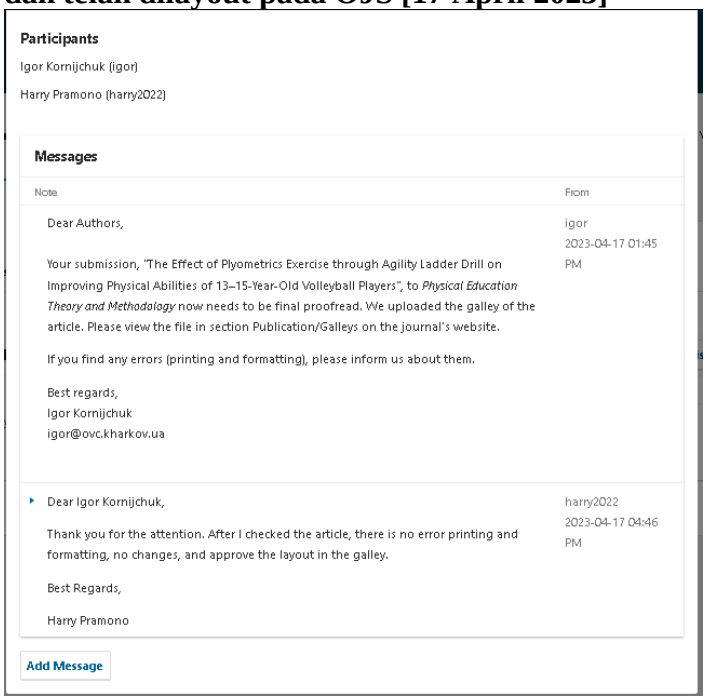
Mengirimkan Bukti pembayaran dan balasan penerimaan pembayaran dari Editor melalui OJS [21 Maret 2023]



Mendapatkan Notifikasi/pemberitahuan dari e-mail terkait artikel memasuki tahapan production pada OJS [22 Maret 2023]



Mendapatkan Notifikasi/pemberitahuan di OJS terkait artikel telah diupload di galley dan telah dilayout pada OJS [17 April 2023]



Journal Publish pada web jurnal dan artikel pdf telah muncul [28 April 2023]

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

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

Harry Pramono[1ABCDE], Tandiyo Rahayu[1ABCDE] and Dewangga Yudhistira[1ABCDE]

[1]Universitas Negeri Semarang

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Harry Pramono, E-mail: hpr4mono@mail.unnes.ac.id
Accepted for Publication: January 21, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.07

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

ТМФВ
ТОВ ОВС

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 (Buśko 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 (Sulistiyono 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 (Rubley 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				Postest			
		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 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).

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

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

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.

Acknowledgment

The author would like to thank the Semarang State University, Faculty of Sports Science, for their assistance in completing this research appropriately. Furthermore, the authors would like to thank the team for assisting in the collection of research data, which allowed this study to proceed successfully.

Conflict of interest

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

References

Zech, A., Hollander, K., Junge, A., Steib, S., Groll, A., Heiner, J., Nowak, F., Pfeiffer, D., & Rahlf, A. L. (2022). Sex differences in injury rates in team-sport athletes: A systematic review and meta-regression analysis. *Journal of Sport and Health Science, 11*(1), 104-114. https://doi.org/10.1016/j.jshs.2021.04.003

Duan, C. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal, 60*(5), 4299-4306. https://doi.org/10.1016/j.aej.2021.03.006

Rahmi, S., & Bachtiar, I. (2020). The Contribution the Physical Condition on Underhand Serve Ability in Volleyball of Elementary School Students in Makassar City. *In 3rd International Conference on Education, Science, and Technology (ICEST 2019)* (pp. 296-299). Atlantis Press. https://doi.org/10.2991/assehr.k.201027.062

Young, M. E. M., Goslin, A., Potgieter, N., Nthangeni, S., & Modise, J. (2011). Sport and recreation participation preferences in the Botswana Defence Force: sport and recreation participation. *African Journal for Physical Health Education, Recreation and Dance, 17*(s 1), 134-145. https://doi.org/10.4314/ajpherd.v17i3.68082

Suh, Y. I., Kim, J., Lee, S., Han, S., & Park, S. H. (2022). A qualitative investigation of leisure benefits for social and psychological health among international volleyball players living in South Korea. *International Journal of Qualitative Studies on Health and Well-being, 17*(1), 2131216. https://doi.org/10.1080/17482631.2022.2131216

Bloshchynsky, I., Kovalchuk, R., Balendr, A., Aloshyna, A., Bahas, O., Mozolev, O & Prontenko, V. (2019). *The conceptual basis of the organization of volleyball team training.*

Kolev, P. (2020). Research of adolesencent volleyball palayers intrinsic motivation for achievement of high sports results. *Research in Kinesiology, 48*(1-2), 35-37. https://doi.org/10.46705/rik201-20035k

Balyi, I., & Way, R. (2013). Long-term athlete development. *Choice Reviews Online, 51*(09). https://doi.org/10.5860/choice.51-5081

Bompa, T. O., & Buzzichelli, C. (2019). *Periodization: theory and methodology of training*. Human kinetics.

Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching, 11*(3), 410-421. https://doi.org/10.1177/1747954116645013

Taware, G. B., Bhutkar, M. V., & Surdi, A. D. (2013). A profile of fitness parameters and performance of volleyball players. *Journal of Krishna Institute of Medical Sciences University, 2*(2), 48-59.

Wicaksono, D., Hidayatullah, F., Kristiyanto, A., & Purnama, S.K. (2022). The Effect of Training Based on Part And Whole Combinations on Smash Techniques Improvement in Volleyball Sports for 11-12 Year Old

Athletes. *Physical Education Theory and Methodology, 22*(1), 62-69. https://doi.org/10.17309/tmfv.2022.1.09

Brendan, J., Tompsett, C., Burkett, B., & Mckean, M. R. (2014). Development of physical literacy and movement competency: A literature review. *Journal of fitness research, 3*(2), 53-74.

Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *British journal of sports medicine, 50*(1), 3-7. https://doi.org/10.1136/bjsports-2015-094621

Buśko, K., Michalski, R., Mazur, J., & Gajewski, J. (2012). Jumping abilities in elite female volleyball players: Comparative analysis among age categories. *Biology of Sport, 29*(4), 317-319. https://doi.org/10.5604/20831862.1022654

Alsaudi, A. T. B. D. (2020). The Influence of Drill Exercise and Eye Coordination Foot Methods Toward the Smash Skill of Badminton. *In 1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)* (pp. 76-82). Atlantis Press. https://doi.org/10.2991/assehr.k.200219.021

Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Physical Education Theory and Methodology, 21*(2), 173-179. https://doi.org/10.17309/tmfv.2021.2.11

Jastrzbeski, Z., Wnorowski, K., Mikolajewski, R., Jaskulska, E., & Radziminski, L. (2014). The effect of a 6-week plyometric training on explosive power in volleyball players. *Baltic Journal of Health and Physical Activity, 6*(2), 1. https://doi.org/10.2478/bjha-2014-0008

Radcliffe, J., & Farentinos, R. (2015). *High-Powered plyometrics* (2nd ed.). Human Kinetics

Pratama, N. E., Mintarto, E., Kusnanik, N. W., & Pratama, N. (2018). The influence of ladder drills and jump rope exercise towards speed, agility, and power of limb muscle. *Journal of Sports and Physical Education, 5*(1), 22-29.

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences, 8*(5), 211-216. https://doi.org/10.13189/saj.2020.080508

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences, 9*(5), 1051-1057. https://doi.org/10.13189/saj.2021.090527

Yulianto, W. D., & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science, 9*(3), 60-65. https://doi.org/10.7575/aiac.ijkss.v.9n.3p60

Jones, N. B., & Ledford, E. (2012). Strength and conditioning for Brazilian jiu-jitsu. *Strength & Conditioning Journal, 34*(2), 60-69. https://doi.org/10.1519/ssc.0b013e3182405476

Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research, 25*(1), 129-134. https://doi.org/10.1519/jsc.0b013e3181b94a3d

Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *Journal of sports science & medicine, 16*(4), 527. https://doi.org/10.1123/pes.2017-0178

Idrizovic, K., Gjinovci, B., Sekulic, D., Uljevic, O., João, P. V., Spasic, M., & Sattler, T. (2018). The effects of 3-month skill-based and plyometric conditioning on fitness parameters in junior female volleyball players. *Pediatric exercise science, 30*(3), 353-363. https://doi.org/10.1123/pes.2017-0178

Fathi, A., Hammami, R., Moran, J., Borji, R., Sahli, S., & Rebai, H. (2019). Effect of a 16-week combined strength and plyometric training program followed by a detraining period on athletic performance in pubertal volleyball players. *The Journal of Strength & Conditioning Research, 33*(8), 2117-2127. https://doi.org/10.1519/jsc.0000000000002461

Maćkała, K., Synówka, A., Ćorluka, M., & Vodicar, J. (2021). Impact of Plyometric Training on the Power of Lower Limbs in Moderately Advanced Female Volleyball Players. *Acta Kinesiologica, 15*(1), 5-12. https://doi.org/10.51371/issn.1840-2976.2021.15.s1.1

Ramirez-Campillo, R., Sanchez-Sanchez, J., Romero-Moraleda, B., Yanci, J., García-Hermoso, A., & Manuel Clemente, F. (2020). Effects of plyometric jump training in female soccer player's vertical jump height: A systematic review with meta-analysis. *Journal of Sports Sciences, 38*(13), 1475-1487. https://doi.org/10.1080/02640414.2020.1745503

Watkins, C. M., Gill, N. D., Maunder, E., Downes, P., Young, J.D., McGuigan, M. R., & Storey, A. G. (2021). The Effect of Low-Volume Preseason Plyometric Training on Force-Velocity Profiles in Semiprofessional Rugby Union Players. *The Journal of Strength & Conditioning Research, 35*(3), 604-615. https://doi.org/10.1519/jsc.0000000000003917

Boichuk, R., Iermakov, S., & Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage. *Journal of Physical Education and Sport, 17*(1), 327-334. https://doi.org/10.7752/jpes.2017.01048

Budiman, I. A. (2016). Development model of volleyball spike training. *International Journal of Sports Physical Education, Sport, and Health, 3*(3), 466-471.

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *Journal of Strength & Conditioning Research, 23*(S5), S60-S79. https://doi.org/10.1519/jsc.0b013e31819df407

Franchini, E., Nunes, A. V., Moraes, J. M., & Del Vecchio, F. B. (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of physiological anthropology, 26*(2), 59-67. https://doi.org/10.2114/jpa2.26.59

Edoya, A. A., Miltenberger, M. R., & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: a systematic review. *Journal of Strength & Conditioning Research, 29*(8), 2351-2360. https://doi.org/10.1519/jsc.0000000000000877

Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British journal of sports medicine, 41*(6), 349-355. https://doi.org/10.1136/bjsm.2007.035113

Vassil, K., & Bazanovk, B. (2012). The effect of plyometric training program on young volleyball players in their usual training period. *Journal of Human Sport and Exercise, 7*(1), S34-S40. https://doi.org/10.4100/jhse.2012.7.proc1.05

Wang, Y., & Zhang, N. A. (2016). Effects of plyometric training on soccer players. *Experimental and therapeutic medicine, 12*(2), 550-554. https://doi.org/10.3892/etm.2016.3419

Ichailidis, Y. I. M., Fatouros, I. G., Primpa, E., Michailidis, C., Avloniti, A., Chatzinikolaou, A., & Kambas, A. (2013). Plyometrics' trainability in preadolescent soccer athletes. *Journal of Strength & Conditioning Research, 27*(1), 38-49. https://doi.org/10.1519/jsc.0b013e3182541ec6

Booth, M. A., & Orr, R. (2016). Effects of Plyometric Training on Sports Performance. *Strength & Conditioning Journal, 38*(1), 30-37. https://doi.org/10.1519/ssc.0000000000000183

Meszler, B. (2019). European Journal of Integrative Medicine Combined strength and plyometric exercise training improves running economy and muscle elastic energy storage and re-use in young untrained women. *European Journal of Integrative Medicine, 28*(November 2018), 86-91. https://doi.org/10.1016/j.eujim.2019.05.004

Markovic, G., Arkovic, G. O. M., Ukic, I. G. O. R. J., & Ilanovic, D. R. M. (2007). Effects of sprint and plyometrics training on muscle function and athletic performance. *Journal of Strength and Conditioning Research, 21*(2), 543-549. https://doi.org/10.1519/R-19535.1

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine, 40*(10), 859-895. https://doi.org/10.2165/11318370-000000000-00000

Davies, G. (2015). Current concepts of plyometrics exercise. *International Journal of Sports Physical Therapy, 10*(6), 760-786.

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. *Scandinavian journal of medicine & science in sports, 20*(4), 556-567. https://doi.org/10.1111/j.1600-0838.2009.01083.x

Meylan, C., & Malatesta, & D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *Journal of Strength & Conditioning Research, 23*(9), 2605-2613. https://doi.org/10.1519/jsc.0b013e3181b1f330

Martínez-López, E. J., Benito-Martínez, E., Hita-Contreras, F., Lara-Sánchez, A., & Martínez-Amat, A. (2012). Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes. *Journal of sports science & medicine, 11*(4), 727–735.

Weber, M. L., Lam, K. C., & McLeod, T. C. V. (2016). The effectiveness of injury prevention programs for youth and adolescent athletes. *International Journal of Athletic Therapy and Training, 21*(2), 25-31. https://doi.org/10.1123/ijatt.2015-0034

Akaruk, H. U. M., Inchester, J. A. B. W., Adowski, J. E. S., & Zaplicki, A. D. A. M. C. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *Journal of Strength & Conditioning Research, 25*(12), 3311-3318. https://doi.org/10.1519/jsc.0b013e318215fa33

Ozmen, T., & Aydogmus, M. (2017). Effect of plyometric training on jumping performance and agility in adolescent badminton players. *Turkish Journal of Sport and Exercise, 19*(2), 222-227.

Patel, S. H. (2002). *A descriptive analysis of physical therapists' knowledge of pediatric sports injury diagnosis and management.* D'Youville College.

Baechle, T. R., & Earle, R. W. (Eds.). (2008). *Essentials of strength training and conditioning.* Human kinetics.

Diallo, O., Dore, E., Duche, P., & Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training program on physical performance in prepubescent soccer players. *Journal of sports medicine and physical fitness, 41*(3), 342.

Ingle, L., Sleap, M., & Tolfrey, K. (2006). The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of sports sciences, 24*(9), 987-997. https://doi.org/10.1080/02640410500457117

Potdevin, F. J., Alberty, M. E., Chevutschi, A., Pelayo, P., & Sidney, M. C. (2011). Effects of a 6-week plyometric training program on performances in pubescent swimmers. *Journal of Strength & Conditioning Research, 25*(1), 80-86. https://doi.org/10.1519/jsc.0b013e3181fef720

Medeni, Ö. Ç., Turgut, E., Çolakoğlu, F. F., & Baltacı, G. (2019). Plyometric training combined with jump rope training in female adolescent volleyball players. *Türkiye Klinikleri Sağlık Bilimleri Dergisi, 4*(3), 261-268. https://doi.org/10.5336/healthsci.2018-63472

Myer, G. D., Lloyd, R. S., Brent, J. L., & Faigenbaum, A. D. (2013). How young is "too young" to start training? *ACSM's health & fitness journal, 17*(5), 14. https://doi.org/10.1249/fit.0b013e3182a06c59

Alviana, S. I., Mintarto, E., & Hariyanto, A. (2020). The Effect of Exercise with Ladder Drill Slaloms and Carioca on Speed and Agility. *International Journal for Educational and Vocational Studies, 2*(1), 103-108. https://doi.org/10.29103/ijevs.v2i1.2039

Padrón-Cabo, A., Lorenzo-Martínez, M., Pérez-Ferreirós, A., Costa, P. B., & Rey, E. (2021). Effects of plyometric training with agility ladder on physical fitness in youth soccer players. *International Journal of Sports Medicine, 42*(10), 896-904. https://doi.org/10.1055/a-1308-3316

Robin, K. V., & Raj, Y. L. (2019). Impact of ladder training on the agility performance of footballers. *International Journal of Yogic, Human Movement and Sports Sciences, 4*(1), 1.

Ng, R. S., Cheung, C. W., & Raymond, K. S. (2017). Effects of 6-week agility ladder drills during recess intervention on dynamic balance performance. *Journal of Physical Education and Sport, 17*(1), 306.

Milroy, T. (2010). *Correlation between an Athletes' Consideration of Future Consequences and Their Improvement in Strength, Speed, and Agility with a Six Week Training Program*. Unpublished Master's Thesis). Bozeman, Montana: Montana State University.

Gronwald, T., Törpel, A., Herold, F., & Budde, H. (2020). Perspective of dose and response for individualized physical exercise and training prescription. *Journal of Functional Morphology and Kinesiology, 5*(3), 48. https://doi.org/10.3390/jfmk5030048

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

Гаррі Прамоно[1ABCDE], Тандійо Рахаю[1ABCDE], Деванга Юдхістіра[1ABCDE]

[1]Семарангський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – 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-Уітні.

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-Уітні 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.

Information about the authors:

Pramono, Harry: hpr4mono@mail.unnes.ac.id; https://orcid.org/0000-0002-9673-5823; Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Rahayu, Tandiyo: tandiyorahayu@mail.unnes.ac.id; https://orcid.org/0000-0002-8690-6377; Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Yudhistira, Dewangga: dewanggayudhistira@mail.unnes.ac.id; https://orcid.org/0000-0002-4194-1283; Department of Sport Coaching Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Cite this article as: Pramono, H., Rahayu, T., & Yudhistira, D. (2023). The Effect of Plyometrics Exercise through Agility Ladder Drill on Improving Physical Abilities of 13–15-Year-Old Volleyball Players. *Physical Education Theory and Methodology, 23*(2), 199-206. https://doi.org/10.17309/tmfv.2023.2.07

Received: 17.11.2022. Accepted: 21.01.2023. Published: 28.04.2023