



Effects of Plyometric Exercise of Adolescent Male Volleyball Athletes: A Systemic Review

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ABSTRACT

By looking at previous literature, this study aimed to analyze the construct of plyometric exercise variation. Comprehensive methods are used for these articles, such as searching for articles in database research journals. Semantic, Scopus, Scholar, and Crossref are the data sources for this database. The variety of plyometric exercises and vertical jump skills are the main themes. Fifty-one articles were verified, and then 12 articles were evaluated based on objectives, topics, sample size, research protocols, and results. Plyometric exercises are exercises in which the movements are explosive and, besides being practical, also train muscle strength, muscular endurance, flexibility, and agility. The purpose of volleyball training is so that players can acquire good basic techniques, strengthen physical strength, and develop interests and talents. To improve jumping ability, various exercises are performed from the beginner level. Therefore, the ability to jump and jump is essential for the volleyball game. The novelty in this study is the using a form of plyometric exercise that is varied according to the characteristics of athletes aged 14-17 years that have never previously been applied in volleyball clubs, which is the focus in this study of plyometric exercise variation methods, namely plyometric squat jump, skipping and hurdle hopping. The intensity of the exercise will be adjusted to the characteristics, and physiological development of male athletes aged 14-17 years.

Keywords

Hurdles Jump,
Plyometric,
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INTRODUCTION

Today, every sport of achievement has grown, especially regarding exercises, provided with increasing exercise tools and increasingly sophisticated methods. Like volleyball, the sport is play. However, to play well, many physical parts must be trained. Every sport requires physical exercise to achieve maximum achievement. Physical exercise in each sport is the primary basis for improving technical and tactical training (Edwan et al., 2017). The quality of a volleyball athlete's physical condition, the techniques he uses, the influence of techniques in competing, maturity in competing, and maturity in performing these techniques are all factors that can affect the success of a volleyball athlete in a match. The most important thing that must be mastered is the basic techniques often used by volleyball athletes in matches and the maturity in performing those techniques (Zubaedi & Muhafid, 2023). A volleyball player must be proficient in various techniques, such as serve, passing, setting, spikes, and blocks, while playing volleyball (Suprianti & Paripurna, 2017). Based on the applicable rules of the game of volleyball, the proper movements in the game of volleyball are always based on theories of science such as biomechanics, anatomy, physiology, kinesiology, and other sciences that support the technique (Yanti et al., 2021).

Jumps are significant in volleyball; many people want to learn to make high jumps to reach the ball in a ball game. To improve the ability to jump and jump, a wide variety of exercises are performed from the beginner level. The basic skills of balance, locomotive motion, and manipulation are enhanced, combined, and trained in various situations. So, with proper training based on the characteristics of the athlete, then the exercise will affect and improve the basic technique (Khoirudin et al., 2023). So, the ability to jump or jump is essential in volleyball (Helaprahara, 2017). In addition to practical athlete training in coaching, quality training methods are also needed to support athlete training, one of which is the practice of basic volleyball game techniques (Khoirudin et al., 2023).

The jump smash technique is very dependent on the quality of the leg muscles, and successfully performing the jump smash movement requires the strength and speed of the muscle groups that support the movement. Among these muscle groups, the leg muscle group is the most dominant muscle group supporting a jump. With leg muscle strength, better jumping ability, and easier to smash and block will increase (Indrayana, 2018). When increasing vertical jump exercises, the exercise of developing the explosive power of the leg muscles must be paid attention to. Therefore, good results in vertical jump are influenced by good mastery of technique and good physical condition, one of which is explosive power,

according to Irmansyah (Syahputra et al., 2023). Power is the product of strength and speed; therefore, power training must start with strength and speed training. This means that strength and speed training have been trained first, although there is already an element of power in every strength and speed training (Pratama, 2016). One of the training methods to increase explosive power is the plyometric exercise method.

Plyometrics is an ideal exercise for people trained to become athletes because it helps them improve strength, speed, and stepping (Nugroho & Gumantan, 2020). Plyometrics is an exercise in which the movements are explosive and compelling, and muscle strength, muscular endurance, flexibility, and agility are trained. The study by Dawes (2009) indicated that athletes typically use plyometric exercises to increase their explosive power or ability to generate force rapidly. Ebben's research (2002) also corroborates these findings, demonstrating that the combined method of plyometric exercises can improve stepping height better than other methods. The findings of Dawes and Ebben are further supported by Gomez et al. (2008), who show that leg muscle strength can be enhanced through plyometric and physical exercises. This muscle strength has an impact on the ability to jump vertical jumps. In addition, plyometric training can positively impact physical attributes, such as strength and endurance. Commonly used variations of plyometric exercises include movements of varying intensity, ranging from low, medium, to high (Firmansyah et al., 2024).

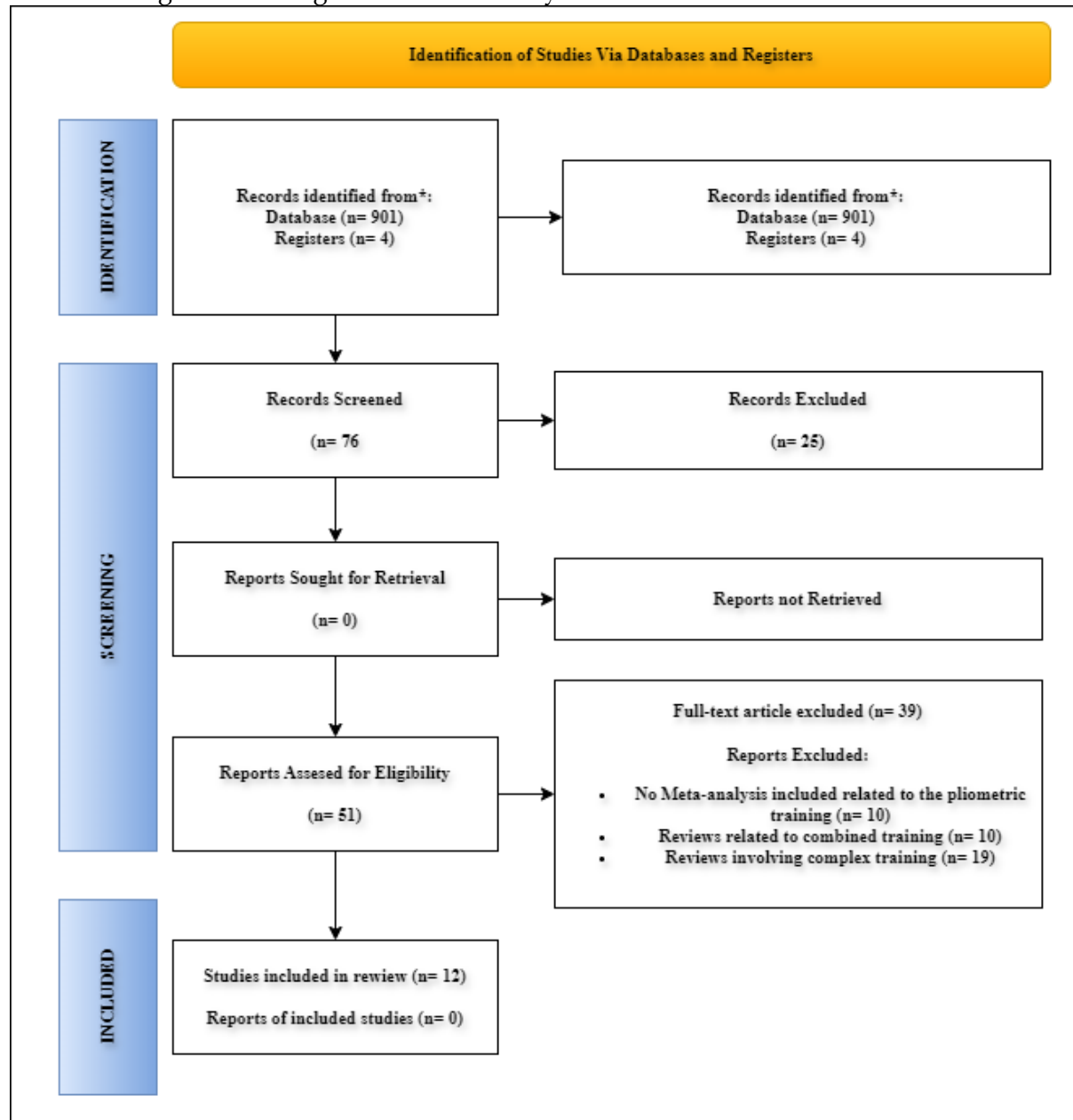
This relatively new methodological approach provides a way to systematically synthesize evidence of the impact of several different interventions on specific outcomes (Higgins et al., 2022) like vertical jump. Therefore, this study aimed to synthesize the findings of other systematic reviews investigating the effect of plyometric exercise variation training on the vertical jump ability of male volleyball players aged 14-17. This plyometric variation needs to be done if this exercise is applied to athletes aged 14-17 years, where this exercise needs to consider the sports experience, readiness, and physiological development characteristics of individual athletes. It is also essential that the training program includes other components (e.g. strength and speed training, nutrition advice, and mental health) that may affect the force of the explosion.

METHODS

Data obtained from the results of literature studies have fulfilled the systemic review stage by making PRISMA (Preferred reporting items for systemic review and meta-analysis). A systematic review will be very beneficial for combining various relevant research results.

This will make the information presented to those who set the policy more complete and balanced. According to (Creswell & Creswell, 2017), a literature review explains the results of other people’s research related to the research to be discussed (Figure 1).

Figure 1
PRISMA Diagram Showing a Flow of the Study Selection



Procedure

Researchers used systematic and comprehensive strategies to search research results from databases, combining search terms such as “plyometric exercise,” “physical condition,” “vertical jump skills,” and “volleyball.” For this review study, the databases used were

Semantic, Scopus, Scholar, and Crossref. The inclusion criteria for this study were articles discussing plyometric exercises, physical condition, skills, and volleyball. Articles published in the last ten years (2019–2023) are included. The study involved male volleyball athletes between the ages of 14 and 17. All study participants actively played volleyball regularly.

Selection Criteria

This study selected questions, keywords, and search strategies using the PICO format (population, intervention, comparison, and results). The analysis is done by dividing the study's results into groups, displayed in tabular form below. The journal search method uses the PICO format (population, intervention, comparison, and results) to find queries and keywords. The analysis was carried out by grouping the results of the study. The goal was to gather information on how different types of plyometric exercises impact improving the vertical jump ability of volleyball club male athletes.

Quality assessment

The Methodological Quality Assessment Checklist for Systematic Review uses the Checklist Abstract Prism Statement, a checklist of 12 items considered essential for accurate reporting of observational studies. This checklist includes the relationship between the article title (item 1), introduction (item 2), method (items 3 to 6), results (items 7 to 8), discussion (items 9 to 10), sections, and other information (items 11 to 12).

Table 1
Quality Score of The Selected Studies

| Study | Quality Score % | Study | Quality Score% |
|-----------------------------|-----------------|--------------------------|----------------|
| (Cojocarú & Cojocarú, 2019) | 50.0 | (Tai et al., 2021) | 83.3 |
| (Fischetti et al., 2019) | 66.7 | (Darusman et al., 2022) | 75.0 |
| (Medeni et al., 2019) | 66.7 | (Febriadi et al., 2022) | 75.0 |
| (Nugroho & Gumantan, 2020) | 50.0 | (Brito et al., 2023) | 83.3 |
| (Khan & Singh, 2021) | 58.3 | (Ozon & Sistiasih, 2023) | 75.0 |
| (Durahim & Sarman, 2021) | 50.0 | (Santana et al., 2024) | 66.7 |

RESULTS

After eliminating duplicates, a systematic search identified 76 potentially relevant studies in the electronic database sought. The full text of 51 articles has been read, and 39 were issued based on predetermined selection criteria. Finally, 12 systematic reviews with meta-analyses are eligible for inclusion in this review.

Table 2
Review of Research Results on Plyometric Exercises

| Author | Sample | Design | Training Model Plyometric | Result |
|---------------------------|---|------------------------------|--|--|
| Cojocaru & Cojocaru, 2019 | 15 – 19 Years Female | Experiment Study | Training programs for the development of containment are applied, focusing on the development of thigh and calf muscles and plyometric exercises. | The vertical jump development program confirmed the working hypothesis that specific parameters of a vertical jump increase |
| Fischetti et al., 2019 | 24 boys, 12–14 years old | Randomized Controlled Study | They were followed by resistance training or resistance training groups (RT, n = 12) who performed static stretching exercises (~20 minutes) followed by the same resistance training program. Both groups conducted exercise sessions twice a week for 90 minutes. At the beginning and after training, all participants were tested on the 20-m sprint (time) and Squat Jump (strength, speed, force, and height)) | Attempting to induce specific acute adaptations in vertical jumping and acceleration capacity in the lower extremities, adolescent boys may benefit more from exposure to a combination of plyometric and resistance training methods. |
| Medeni et al., 2019 | 35 National Youth Volleyball Female Players | Randomized controlled trials | The participants were allocated to two groups: a study group (lower extremity plyometric training combined with jumping rope exercises; n = 18) and a control group (standard volleyball training; n = 17). All subjects were evaluated before and after the 12-week training. | The results of this study show the benefits of adding plyometric exercises to standard training in young female volleyball players. This study will be the basis for developing a training program. |
| Nugroho & Gumantan, 2020 | 20 students out of 25 students who attended Basketball extracurricular activities | Experiment Study | Training plyometric jumps to the box is an exercise. You make jumps by going through block. Each block is 30 cm high and 40 cm long, with a track length of 10 meters. | There is a significant influence on vertical jump ability in students who take extracurricular activities basketball at SMAN 1 Show After participating in plyometric exercises with significance values of $0.000 < 0.05$. |

Table 2 (Continued)

| Author | Sample | Design | Training Model Plyometric | Result |
|------------------------|--|------------------------------|--|--|
| Khan and Singh, 2021 | 24 Males ages 18 to 25 | Randomized Controlled Trials | Three meetings: experiment I, exploration II, and control group Elected members have been created. During the six-week, three-day substitute training group each week, test group I blended plyometric training with exploratory meeting circuit training group II. | The review findings showed that among male volleyball players, there was a significant difference between the post-test method change for the trial group and the control group for some physical and physiological characteristics. |
| Durahim & Sarman, 2021 | 30 people aged 12-15 years | Randomized Controlled Study | The intervention was given two times a week for two months, with 15 people each for the treatment group and 15 for the control group. | Jump height change occurs on volleyball players on giving plyometric exercise |
| Tai et al., 2021 | Ten sons aged 21 | Experiment Study | The participants wore their exercise shoes and shorts, performing a series of Dynamic stretching, warming up for 20 minutes, and practicing spike jumps several times. Then, RSJ-1L and RSJ-2L were performed randomly. Three trials of each spike-jump were collected for each participant. | Current research contributes to understanding the biomechanical differences of volleyball spike jumping and can be used to adapt for volleyball training. |
| Darusman et al., 2022 | Twelve people aged 17-20 years. | Experiment Study | Observations made before the experiment (01) are Pre-test values and post-experiment observations (02), -values Test. | It can be concluded that the Plyometric Method Training (Skipping) affects Leg Muscle Power at the Muara Ngamu Conga Youth Association Volleyball Club (IRC). |
| Febriadi et al., 2022 | 14 male athletes and 12 female athletes aged 18-23 | Randomized Controlled Study | The study was conducted for four weeks with a frequency of exercise, four times a week given plyometric exercises. | There are influences that. Significance of the plyometric training method to the enhancement of power capability Volleyball athlete's limb muscle blast |

Table 2 (Continued)

| Author | Sample | Design | Training Model Plyometric | Result |
|-----------------------------------|--------------------------------|------------------------------|--|--|
| Brito et al., 2023 | 13-15 years | Randomized Controlled Trials | Studio design is similar in style. Experiments in which traditional interventions are implemented. A period of sweet weeks of national and experimental research, with demonstrations. In total, 25 males were in the group. Cuenca volleyball team, located in Ecuador. They are analyzed. The experimental and control groups were used to compare the effects of the plyometrics course. Training plan. | The results of this study suggest that modified plyometric storage with added load or resistance through the use of tools has a statistically significant effect on the Abalakov test, |
| Ozon & Sistiasih, 2023 | 16 male athletes | Randomized Controlled Study | The sample was divided into two groups: the experimental and the control groups. The experimental group will Plyometric standing jump training treatment was given, while the control group was not given any treatment. | Plyometric Exercise Standing jump has a significant influence in improving the vertical jump ability of volleyball players in the club |
| Santana et al., 2024 | 30 adolescents, aged 11 to 14. | Randomized Controlled Trials | The volunteers were divided into a control group, a plyometric training group, and a sprint training group, and they underwent six weeks of training (two sessions per week). Their repeatable sprint capabilities were assessed using photocell technology, and their vertical jump capacity was evaluated on a platform with an interrupt system. | Repeated sprint training has shown its efficacy in enhancing both repeated sprint and vertical jump abilities. |

DISCUSSION

Effect of Plyometric Exercise Variations on Vertical Jump

Meta-analysis is shown by (Campillo et al., 2020) Considering the principle of specificity, 14-year-old volleyball players systematically involved in the plyometric training program showed a positive impact with an 11% improvement over six weeks. In addition, an eight-week plyometric training intervention in 24-year-old male and female volleyball players showed a substantial increase in vertical jump of 6%. The number of jumps performed by volleyball players during training and games varies according to the player's position, with an average of 45 jumping actions performed by players (Chaturvedi et al., 2023). An experimental study of measurements involving observation during six weeks of exercise to

athletes participating in exercise routines for seven training sessions per week and training varied between 60 and 120 minutes (Martinez et al., 2023).

Variations of plyometric exercises are given independently or combined with other exercise programs and performed at varying intensity levels. Various studies have explored the role of plyometric training independently in combination with different training methods. Combination plyometric exercises include depth, countermovement, and squat jumps (Sari et al., 2020). Research conducted by (Ziv & Lidor, 2010) shows that a plyometric depth jump exercise with an intensity of 4 sets with 12 repetitions has a smaller effect than a plyometric depth jump exercise with an intensity of 5 sets with 12 repetitions. Higher exercise intensity in longer workouts can increase the effectiveness of vertical jumps. In addition, exercise with a high intensity in a short period has a more significant effect than exercise with a moderate intensity in a more extended period. Plyometric training effectively improves vertical jump performance in athletes; plyometrics can be applied during annual training, including during the season (Slimani et al., 2016). Plyometric training provides positive changes in neuromuscular structure, increased stretching cycle speed, nerve locomotion, and myotic reflexes, which are responsible for jumping and depend on the duration of the program (Junior et al., 2020).

Information obtained from these studies suggests that repetitive vertical jump ability should be part of volleyball athlete planning. This can contribute to increased vertical jumps, which are an important physical quality for exercise. Coaches are encouraged to identify athlete performance and control or observe plyometric training, considering individual athlete responses.

The Effect of Plyometric Exercise on Physical Performance Improvement in Male Volleyball Players

Volleyball athletes can achieve optimal performance and achievement when they have a sound physical condition. A player must be supported by physical abilities and follow guidance when playing volleyball. The ability to maintain physical condition can be improved according to each sport. According to experts in this field, the necessary physical components include circulatory, heart, respiratory, cardiovascular endurance, explosive power, agility, muscular endurance, reaction, balance, coordination, and flexibility (Dhani, 2023). The elements of physical condition that must be possessed in the game of volleyball are strength, flexibility, agility, speed, and endurance (Is & Rusliadi, 2023). To ensure the ability to perform jumps required during serve, smash, and defense (block), the motor power components of the

limbs and coordination must be appropriately trained and sustained. This exercise perfectly strengthens leg muscles when jumping upwards without a prefix. This is similar to the block movement performed when playing volleyball without a prefix. Because of the movement of this split squat jump exercise, jumping up only uses the strength of the leg muscles, such as swinging the arms to increase lift. After returning to the starting position, bend the front knees to dampen the shock. Once the position is stable, realign as it was (Hardovi, 2019).

Often, this movement is used to connect jumping and jumping movements so that you can stretch the muscles involved in the movement so that an explosive reaction occurs immediately before the muscle contracts again. When performing this plyometric exercise, one factor that significantly affects the ability of the limb muscle is the increase in muscle elasticity (Haetami and Awanis. 2021). In addition, the plyometric exercise design created by the trainer is also adjusted so that training goals can be achieved, which means that the exercise can sustain the athlete in the short term (Fachreza et al., 2023). Therefore, based on the discussion and supported by some of the references above, researchers think that plyometric training is one of the most effective forms of exercise to improve the physical condition of volleyball athletes, especially regarding leg muscle strength.

The Effect of Plyometric Exercise on Physical Performance in Different Age Groups

This overview suggests that plyometric interventions can improve the physical fitness of children and adolescents beyond levels that can only be achieved through growth and maturation. In addition, plyometric interventions improved the physical fitness of middle-aged adults who did not exercise. Plyometric training has been shown to benefit untrained children and adolescents, especially in terms of increased vertical jump height, running speed, and muscle strength (Behm et al., 2017). Planning a four- to five-week pre-workout focusing on low- to moderate-impact running and jumping is essential. Plyometric exercise builds muscle and bone strength to withstand weights and strenuous workouts (Konukman et al., 2018).

Lesinski et al. (2020) recently observed that plyometric training had a small to moderate impact on the lower extremity muscle strength of child and adolescent athletes. Kids can learn plyometrics in a fun way by playing obstacle course games. In this game, they can perform various plyometric techniques over and around various objects (Konukman et al., 2018). Other research also supports that plyometric training improves exercise performance in non-athlete adolescents (Peitz et al., 2018). However, the effects after plyometric exercise appeared to be

influenced by moderation variables such as maturity, sex, and age in the youth group (Clemente et al., 2021; Lesinski et al., 2020). Age and biological maturity greatly influence sex differences in youth volleyball players. The birth quartile appears to have less impact (Saura et al., 2022). Therefore, subsequent research should consider these aspects.

Verification regarding plyometrics carried out by (Vetrovsky et al., 2019) whether plyometric training positively impacts older adults' muscle strength, vertical jump ability, and functional abilities. The six-week plyometric exercise regimen significantly improved all test parameters, including strength, fitness, and agility (Krishnan & Rajawadha, 2020). Therefore, plyometric training can be considered a viable and safe alternative to improving the physical fitness of older adults. Future reserach should further study moderation variables, such as age, conditioning level, and body composition.

CONCLUSION

Based on a review of existing research, the authors of this study aimed to clarify the impact of plyometric exercise variations on young male volleyball players. A well-structured plyometric training program has significant potential to improve the physical performance of volleyball players, with the most notable improvement seen in lower extremity explosive strength, specifically in leg strength. Repetitive vertical jump skills should be part of volleyball athlete planning, which can contribute to increased vertical jumps; this is an important physical quality for exercise, and coaches are encouraged to identify athlete performance and control or observe plyometric training while considering individual athlete responses. Plyometric exercise is one of the most effective forms of exercise to improve the physical condition of volleyball athletes, especially in the aspect of leg muscle strength. Therefore, plyometric exercise variations can be considered a viable and safe alternative to improve the physical fitness of older adults. Moderation variables, such as age, conditioning level, and body composition, should be further studied by future research.

PRACTICAL IMPLICATIONS

A contribution to the application of this literature was to develop and test variations of plyometric exercises that improve young male athletes' vertical jump ability. This plyometric variation exercise program can be used by coaches in adolescents aged 14-17 to improve the vertical jump ability of male volleyball athletes.

Limitations

The findings of this study should be interpreted with caution because of several limitations. First, the participants were young soccer players with amateur backgrounds. Therefore, the findings may not be generalizable to other age groups, skill levels, and competitive contexts. Second, the study only used psychological and technical responses in 2-a-side and 4-a-side game formats. These results may not fully represent the effects of physiological and kinematic parameters. Third, this study only assessed immediate responses during and shortly after game sessions. However, the long-term implications of these observed differences have not yet been explored.

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Authors' contribution

All authors did a joint research design. The first author is involved in the process of data collection, writing and interpretation of the data as well as approval of the final draft. The second author is involved in the process of data collection, writing and interpretation of data and approval of the final draft. Third, the author of data interpretation and critical review of the original draft as well as approval of the final draft. The fourth author is the interpretation of the data and critical review of the original draft as well as the approval of the final draft. The fifth author is the interpretation of the data and critical review of the original draft as well as the approval of the final draft. All authors contribute to the discussion of the results and preparation of the manuscript.

Declaration of conflict interest

The authors declare that they have no conflict of interest.

Ethics Statement

In the research carried out, we applied honesty in searching for data. We were open to all the references we obtained so that we could carry out a literature review responsibly and correctly according to existing scientific principles.

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