Development of High Intensity Interval Training (HIIT) for Reactive Agility Tennis: Literature Review and Validity of Aiken

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Research

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Abstract

Background

The purpose of this study was to examine High Intensity Interval Training (HIIT) for Reactive Agility Tennis with a literature review approach and develop HIIT for Reactive Agility Tennis with Aiken validation.

Methods

This research method consists of two stages: the first stage using the Literature review method and the second stage is Aiken validation. In the first stage, the participants of this research used documents. Data collection through the Pubmed database, and Google Scholar, used the PRISMA. Data analysis uses thematic analysis through three stages. The second stage is validating the HIIT model for Reactive Agility Tennis. The participants of this study used eight experts. Data analysis using the Aiken formula.

Results

the results of previous research on HIIT for reactive agility tennis found similarities, namely in general, using high intensity, a minimum number of eight types, training frequency at least 3 times per week, whereas in general the difference in training intervals, the type of HIIT exercise in previous studies for Increases reactive tennis agility. In addition, there are very few HIIT studies for reactive agility in tennis. Therefore, it is necessary to develop HIIT for reactive agility tennis. The second stage of this research has found a high validity of Aiken value in the development of HITT for reactive agility tennis.

Conclusions

HIIT highly increasing reactive tennis agility, therefore, HIIT can be used by coaches to increase tennis athletes' reactive agility, and further research needs to be done.

Systematic Review registrations:

SYSR-D-21-00999

Introduction

Tennis is a game that requires accelerating changes in direction and making repeated and varied strokes, such as different types of ball speed, varying ball spins. And it can be placed at various angles court, so tennis athletes need swift neuromuscular coordination to respond to the ball quickly (Ziagkas, 2019).

Changes in position quickly and precisely to maintain position in hitting the ball as it is necessary to optimize conditioning for tennis which requires consideration of various physical and physiological elements relevant to competition (Torres-Ronda, Ric, Llabres-Torres, de Las Heras, & Schelling, 2016).

The characteristics of the tennis game require acceleration of changes in direction and repeated strokes with high intensity in a relatively varied time (Ziagkas, 2019). Achieving tennis performance requires physical components of speed, agility, reaction, balance, coordination, and endurance (Bashir, 2018). Agility, reaction speed, and early response are essential abilities for tennis athletes to return a blow from an opponent. Agility and reaction speed are crucial factors for tennis players in carrying out any changing movements (Reid, 2013). Agility and reaction speed is the ability of a player to maintain or control body position and change direction quickly in various movements after receiving a stimulus (Ziagkas, 2019, Yudhistira, 2020). Speed, agility and explosive power have a high impact on success in tennis (Smajić et al., 2015) Why is reactive agility necessary for tennis? Because it can help move the body back, sideways, and forward quickly after receiving a stimulus during play (Warren B. Young, et al., 2015)

Reactive agility is the ability to make changes in motion quickly in response to a stimulus without losing balance (Young W., Farrow D., Pyne D., McGregor W., Handke T, 2015). Agility is defined as making rapid and dynamic changes in the movement without losing balance (Makhlouf et al., 2018; Jovan et al., 2015). The limitations of agility so far have not emphasized specific sports work. Besides that, they have not paid attention to the perception component in which athletes get stimulated and make decisions when motion changes (Ooi et al., 2009,). Tennis games rely on fast movements without losing balance in making strokes and the speed of response to the given stimulus. This complexity requires tennis athletes to have fast reaction times and explosive "first step" speed (Kovacs., 2006). Therefore, training to improve reactive agility is very important for tennis athletes in achieving maximum performance.

High-intensity interval training (HIIT) has been advocated as a competitive sport-specific conditioning strategy (Franchini et al., 2019), including tennis and martial arts. High-intensity interval training (HIIT) is an effort (practice) repeated in a short time with high intensity interspersed with a rest period. Each interval between repetitions (work) is longer than that is 40-60 seconds. Why? Because when the training load increases, the dependence of intramuscular adenosine triphosphate (ATP) and phosphocreatine (PCr) also increases to supply the energy for the muscle contraction. (Harris, 1976). ATP recovery takes 3-5 minutes, whereas PCr recovery takes 8 minutes, thus creating the need for longer rest intervals to maintain a higher volume of exercise (Filho, 2013). Several studies suggest that HIIT is feasible and time-efficient for improving athletic performance and sport-specific skills (Engel et al., 2018) by utilizing various sprints with intermittent rest periods. However, it is not familiar about the effect of HIIT on tennis. Therefore, developing a HIIT program based on various work and rest ratios is necessary to improve reactive tennis agility.

This study aims to develop a HIIT program for reactive agility tennis with a literature review approach and Aiken analysis based on the description above..

Methods And Materials

Literature review and expert assessment are the methods used in this study. A literature review is a systematic, explicit and reproducible method for identifying, evaluating, and synthesizing research results and ideas that have been produced by researchers and practitioners (Okoli & Schabram, 2010). Why use this method? It is currently not possible to conduct research directly while social distancing. The expectation by using this literature review and expert assessment method is to open the possibility to develop a physical exercise model for the reactive agility of tennis athletes.

In this study, data were collected through the Pubmed database and Google Scholar. After collecting data through the database, the researcher used the PRISMA (Preferre Reporting Items for Systematic Reviews and Meta-Analysis) technique to obtain the desired article for research. Determining the paper to be researched has four steps, namely (1) identification, (2) screening, (3) eligibility, and (4) inclusion.

Identify articles through journal searches. The researcher opened the website for each of the databases mentioned above. Then the researcher wrote down the keywords, namely "reactive agility and interval training". Researchers found 876 articles from the database and wrote keywords and "effect interval training for reactive agility" got 812 findings.

Researchers screened articles by determining inclusion and exclusion criteria. Inclusion criteria include articles in English, articles used in research results, and articles that are accessible. The exclusion criteria included articles published in the year above 2009. After that, the researchers then specified reports with inclusion and exclusion criteria; for articles in English, 60 findings were obtained because they were not following the researcher's objectives, namely the effect of physical exercise on reactive agility.

Researchers determine excellent articles or original research and discuss interval training for reactive agility for net game sports, used for a literature review. After the paper meets the eligibility, the number of articles to be researched will be obtained. The number of reports received was five articles that were studied.

Data analysis is critical for researching because data processing is related to concluding. Analysis of the data used is by using thematic analysis. Thematic analysis is one way to get results by conducting data analysis that aims to identify patterns or determine themes through data that has been collected by research (Braun & Clarke, 2006). There are three stages, including (1) Compare: find similarities between several pieces of literature. (2) Contrast: find differences between several kinds of literature and conclude. (3) Criticize: give your own opinion based on the sources you read.

The results of the literature review serve as the basis for developing HIIT for reactive agility tennis. After compiling High Intensity (HITT) and reactive agility interval training based on the literature review results, it was continued to be strengthened by expert testing with the Delphi technique. The results of the expert assessment were then analyzed using the Aiken formula.

Results

The results of the HIIT Literature Review found research results that deserve to be studied as table 1 as follows.

The research above has similarities, using high intensity, a minimum of eight types, training frequency at least 3 times per week. In contrast, there are generally differences in training intervals,

types of HIIT training and research objectives. to improve sports performance. Therefore, HIIT still needs to be developed to improve the performance of each type of sport.

The results of the Literature Review on Increasing Reactive Agility were found to be worthy of study, as shown in Table 2 as follows.

Table 2 states that the relevant research used in this study has differences in research methods that focus on experiments while the current research uses the literature review method. The similarity of this research with relevant research is to make reactive agility the main topic that will be discussed in the study. There is a lack of information about reactive agility in one sport, so researchers want to research reactive agility specifically for tennis, which can later be used as a reference source for further researchers.

Based on the literature review, researchers developed HIIT for reactive agility in tennis. The HIIT program for reactive agility is, as shown in Table 3 as follows:

Y Dynamic Run

A form of exercise in which the athlete runs through the ladder after listening to the signal, then sees the flag sign from the coach to run towards the raised flag immediately.

Reactive Ledder Ball

An exercise where the athlete stands in front of the coach with 3m distance(ball thrower), the coach throws the ball to the throw, and the athlete stands in the middle between the ladder by 3m

distance, the athlete is directed to catch the ball, quickly. After catching, the athlete is required to move following the direction of the ball and perform back and forth movement through the ladder

Zig-Zag Run and Reactive Ball

Zigzag running with 1-meter distance where each cone is 7 meters long. And it ends with the athlete running on the spot to get ready to catch the tennis ball as fast as possible and return to the previous endpoint. Chasing the ball is carried out 3 times.

Run and Reactive Step

An exercise that the athlete must touch the cone immediately and then return as soon as possible to the starting box where the athlete started the movement. In the starting box, the athlete performs a ready-to-move position by running in place.

Reactive Agility Shadow

Reactive Agility shadows is an exercise that relies on shadows while the athlete is at a point in the middle holding a tennis racket and preparing to listen to the coach's signal. The athlete runs at the point of the cone, then performs 1 basic movement in hitting the ball and returns to the starting point.

T Dynamic Run

This exercise is almost the same as the Y Dynamic Run exercise. The difference is that the athlete advances by opening the lid and jumping forward after passing the ladder after listening to the signal, then seeing the flag sign from the coach to take a quick step towards the raised flag immediately.

Expert Test Results

8 experts analyzed the results of the expert assessment with the Aiken formula. as shown in Table 4 as follows

Based on table 4 in point 1, namely the type of activity according to the concept of reactive agility, the Aiken value of 0.875 is categorized as having high expert agreement; in item 2, namely the frequency of training following the idea of training, Aiken's value of 0.875 is categorized as an expert who has very high agreement; and in point 3, namely rest between activities by the concept of training, the Aiken value of 0.917 is categorized as an expert who has very high agreement; while in item 4, namely rest between sets according to the concept of physiology, Aiken's value is 0.917 with expert categorization as having very high agreement.

Discussion

Reactive agility in tennis is an essential element needed by athletes to achieve peak performance. The role of reactive agility in tennis is necessary for a match and practice. At the time of training or competition, athletes need one of the factors, namely reactive agility, to make movements as quickly as possible or move as fast as possible after receiving a stimulus without losing balance. Reactive agility is a combination of changes in direction speed and components of stimulation and information processing. Reactive agility is an integral part of many sports, especially tennis, characterized by 3 stages of information processing: stimulus perception, response selection, and movement execution. In improving the reactive agility ability, it is necessary to have planned exercises following the characteristics of tennis. Structured exercises are needed to enhance tennis performance. The long-term training model is continuous and changes continuously because the training model will develop related to the athlete's development. The training model development is a series of intensive processes associated with the previous model, evaluating the current athlete.

Tennis characteristics have a more dynamic and explosive movement characterized by higher strokes and speed of service and the primary need for higher physical demands (Kovacs, 2007). The created exercise program was conducted in consultation with experts to obtain content validity results from an instrument. According to content validity is related to the extent to which the instrument assessor measures the exercise program is appropriate or not.

High intensity Interval Training (HIIT) is a form of exercise commonly used to increase physical activity among athletes and improve sport-specific performance (Eugenia et al, 2020). Research on High intensity Interval Training (HIIT), has emerged in recent years as an efficient way of increasing physical ability because it refers to high intensity and alternating recovery periods. It has become an alternative and popular exercise mainly because of its time efficiency (Martin et al, 2020). The basis of HIIT training is to perform maximum performance repetitions with alternating breaks (Billat, 2001). The advantage of HIIT is its short duration and variety of exercises that make training sessions less monotonous (Kimm et al, 2006). HIIT training suggests being a fun and exciting exercise for athletes (Jung et al, 2014). Why is it necessary to use a form of HIIT exercise? This exercise has the advantage of short duration, varied, and can improve special physical abilities, especially tennis. Combining the HIIT training program specifically for tennis can increase the reactive agility performance of tennis athletes in reaching peak performance. Reactive agility training program specifically for tennis characteristics produced: Y Dynamic Run, Reactive ladder ball, Zig-zag Run and Reactive Ball, Run and Reactive Step, Reactive Agility Shadow, T Dynamic Run. The assessment results from the experts on the first item regarding the exercise program according to the reactive agility concept, getting a V value of 0.875, says that the training program is under the reactive agility concept. The assessment results in the second item regarding the frequency of getting a V value of 0.875 state that the frequency of the exercise program is appropriate. The results of the third item assessment regarding rest between activities (exercise/practice) get a V value of 0.917, which says that rest between movements is appropriate. The results of the fourth item assessment regarding recovery between sets get a V value of 0.917. From the expert's assessment results, the tennis performance reactive agility training program is valid. So it concludes that the average value of each item of expert assessment is above 0.75. In other words that the moderate score expert agreement is excellent. The results of this study are reinforced by Fleiss (1975), who states that the category of agreement value between raters is a value above 0.75, an excellent agreement, and a value of 0.40 – 0.75 good agreement. It is also reinforced by the opinion of Aiken (Aiken, 1985), which stipulates the minimum standard of V Aiken is 0.75, a good agreement with a probability of 0.041.

Conclusion

Based on the results and discussion, HIIT highly increasing reactive tennis agility. Therefore, HIIT can be used by coaches to increase tennis athletes' reactive agility, and further research needs to be done.

Declarations

The writing team would like to thank to the Yogyakarta State University and the Indonesian Tennis Association for helping and providing the opportunity to collect the data and finish this paper smoothly. Hopefully, the article is useful and can help others to continue and develop for further research.

Author's contributions

AA, T, NA, and HW develop this research concept. T, NA, and HW developed a concept search exercise. AA finalizes the exercise concept. F analyzed the data in this research. All authors agree to this manuscript.

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Availability of data and materials

There is no data applicable to the current protocol. The data extracted and analysed in the prospective review will be made available from the corresponding author on request

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Competing interests

The authors declare they have no competing interests.

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Tables

Table 1. The results of previous studies that are worthy of review in this study

Name	Title	Method/ instrument/ sample	Protocol	Analysis	Results
William TB Eddolls; Melitta A. McNarry; Gareth Stratton; Charles ON Winn; Kelly A. Mackintosh	High-Intensity Interval Training Intervention in Children and Adolescents: A Systematic Review	The literature review method with an initial sample of 2092.	1) studying healthy children or adolescents (5–18 years old); 2) prescribe interventions that are considered high-intensity; and reporting health-related outcome measures.	Then specified criteria. From 13 studies were deemed suitable. This review found that high-intensity interval training in children and adolescents is a time-effective method for improving cardiovascular disease biomarkers. Still, the evidence regarding other health-related measures is vaguer. Running-based sessions, at an intensity of [90% maximum heart rate/100- 130% maximal aerobic speed, two to three times weekly and with an intervention duration of at least seven weeks, resulted in the most significant improvement in participants' health.	A total of 2,092 studies were initially drawn from four databases. Studies deemed to meet the criteria were downloaded in their entirety and independently assessed for relevance by the two authors using pre-defined criteria. From 13 studies were considered suitable. This review found that high-intensity interval training in children and adolescents is a time-effective method for improving cardiovascular disease biomarkers. But regarding other health-related actions, it is vaguer. Running-based sessions, at an intensity of [90% maximum heart rate/100-130% maximal aerobic speed, two to three times weekly and with an intervention

					duration of at least seven weeks, resulted in the most significant improvement in participants' health.
Breno B. Vasconcelo; Gabriel V. Protzen; Leony M. Galliano; Christopher Kirk; Fabrício B. Del Vecchio	Effects of High-Intensity Interval Training in Combat Sports:	A systematic review with meta-analysis was performed using the PRISMA protocol. A total of 2,111 samples notes	Bias Risk in Individual Studies. Each study's methodological quality tested using the TESTEX scale, which only used to characterize studies methodological quality, and not as a criterion exclusion. Publication bias calculated for each results.	The meta-analysis performed the calculation of the unadjusted odds ratio (OR) taking into account random effects, based on the number of samples and each outcome mean and standard deviation before and after the intervention. Statistical heterogeneity between studies evaluated using Cochran's Q and I ² tests, considering heterogeneity for I ² above 50%. Publication bias was verified visually using funnel plots. All analyzes performed using Review Manager version 5.3.5	HIIT positively affects maximum oxygen uptake and anaerobic power in combat sports athletes, with little impact on body composition

Table 2. The results of previous studies that are worthy of review in this study

Name	Title	Method/ instrument/ sample	Protocol	Result
Dominic G. McNeil, Michael Spittle & Christopher Mesagno	Imagery training for reactive agility: Performance improvements for decision time but not overall reactive agility	Experiment	Forty-seven female athletes range age from 19 up to 28 years. Pre- test and The RAT post- test consisted of four practice trials and 12 trials RAT (16 trials total per session). Each training session lasts approx 20 minutes, and all participants adhere to at least 24 hours of rest between training sessions. After completing all six training sessions, all (including the control group) participants completed post-test and VMIQ-2 again.	<p>The use of imagery for decision time variables related to performance reactive agility lightstimulus.</p> <p>The lack of overall improvement in reactive performance may indicate that imagery training is not practical for all components of perceptual-motor performance.</p>
Jay R. Hoffman	Evaluation of A Reactive Agility Assessment Device in Youth Football Players	Experiment	Thirty-one male soccer athletes. The subject were tested with 3 exercises reactive agility (side shuffle reactive agility, reactive agility 1 m, and reactive agility 3 m). Besides, doing three agility exercises traditional: pro agility, T drill, and L drill.	This study indicates that the reactive agility device BlazePod is a reactive agility performance measure that is reliable and consistent with the coach's perception of the athlete's agility performance, thereby demonstrating construct validity.
Samo Rauter; Milan Coh; Janez VodiCar; Milan Zvan; Josef Krizaj; JoZef Simenko; Lukasz Szmajda;	Analysis of reactive agility and change-of-direction speed between soccer players and physical education students	Experiment	The two groups in the study included 36 young male and female soccer players and 58 male and female physical education students. Examined the difference between reactive agility (RA) as an unplanned (randomly selected stimulus) movement and velocity of change of direction (CODS) as a pre- planned movement among different levels of sports performance - young soccer	Football players were significantly faster in the selection of CODS and RA tests.

Table 3. Interval training for reactive agility tennis

Table 4. Results of expert assessment of the design of the tennis reactive agility training program

Week	Frequency /week	Intervals between activities (second)	Set	Break between sets (seconds)	Activity
1	3	60	2	180	1. Y DynamicRun 2. Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 6. T Dynamic Run
2	3	60	2	180	Y DynamicRun Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 6. T Dynamic Run
3	3	60	3	180	1. Y DynamicRun 2. Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 6. T Dynamic Run
4	3	60	3	180	1. Y DynamicRun 2. Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 6. T Dynamic Run
5	3	60	4	180	1. Y DynamicRun 2. Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 6. T Dynamic Run

6	3	60	4	180	1. Y DynamicRun 2. Reactive ladderball 3. Zig-zag Run and ReactiveBall 4. Run and ReactiveStep 5. Reactive AgilityShadow 7. T Dynamic Run
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Evaluator	Aspect 1		Aspect 2		Aspect 3		Aspect 4	
	Score	s	Score	s	Score	s	Score	S
1	4	3	4	3	4	3	4	3
2	4	3	3	2	3	2	4	3
3	3	2	3	2	4	3	4	3
4	4	3	4	3	4	3	3	2
5	4	3	4	3	4	3	4	3
6	3	2	3	2	3	2	4	3
7	4	3	4	3	4	3	4	3
8	3	2	4	3	4	3	3	2
Σ s		21		21		22		22
V		0.875		0.875		0.917		0.917