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THE EFFECTS OF DIFFERENT EXERCISE PROGRAMS ON THE DEVELOPMENT OF TENNIS PLAYERS' AGILITY: A SYSTEMATIC REVIEW

EFEKTI PROGRAMA VEŽBANJA NA RAZVOJ AGILNOSTI KOD TENISERA JUNIORSKE KATEGORIJE: SISTEMATSKO PREGLEDNO ISTRAŽIVANJE

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Abstract

The aim of this research was to investigate the effects of different exercises on the development of tennis players' agility. The electronic database PubMed was used to search and collect relevant studies in the field of agility in tennis. This study was conducted based on the PRISMA statement. A total of 361 participants were included in this study. Twelve studies met the criteria in order to be included in this study. The results showed that the effect was statistically significant after each exercise program (high-intensity interval training, court tennis training, neuromuscular warm-up, sport-specific training, plyometric training, neuromuscular and performance training). The exercise programs lasted from 5 - 12 weeks with a weekly frequency of three times for 45 to 90 minutes. The results, obtained in this way, indicate a sensitive period for the development of agility in this age group, i.e. junior tennis players. The analyzed areas of agility assessment, frontal and lateral agility observed on the basis of agility assessment tests, were singled out.

Keywords:
Change of direction, T-test, 505 agility test, Tennis, Junior players, Physical program.

Sažetak

Cilj ovog istraživanja bio je da se ispitaju efekti različitih vežbi treninga na razvoj agilnosti kod tenisera. Za pretragu I prikupljanje relevantnih studija iz prostora agilnosti u tenisu korišćena je elektronska baza podataka PubMed. Ova studija je sprovedena prema prizma standardu. Ukupno 361 učesnik je bio uključen u ovu studiju. Dvanaest studija je ispunilo kriterijume za uključivanje u ovu studiju. Rezultati su pokazali da je efekat bio statistički značajan nakon svakog

Ključne reči:
Promena smera, t-test, 505 test agilnosti, tenis, juniori, programi vežbanja.

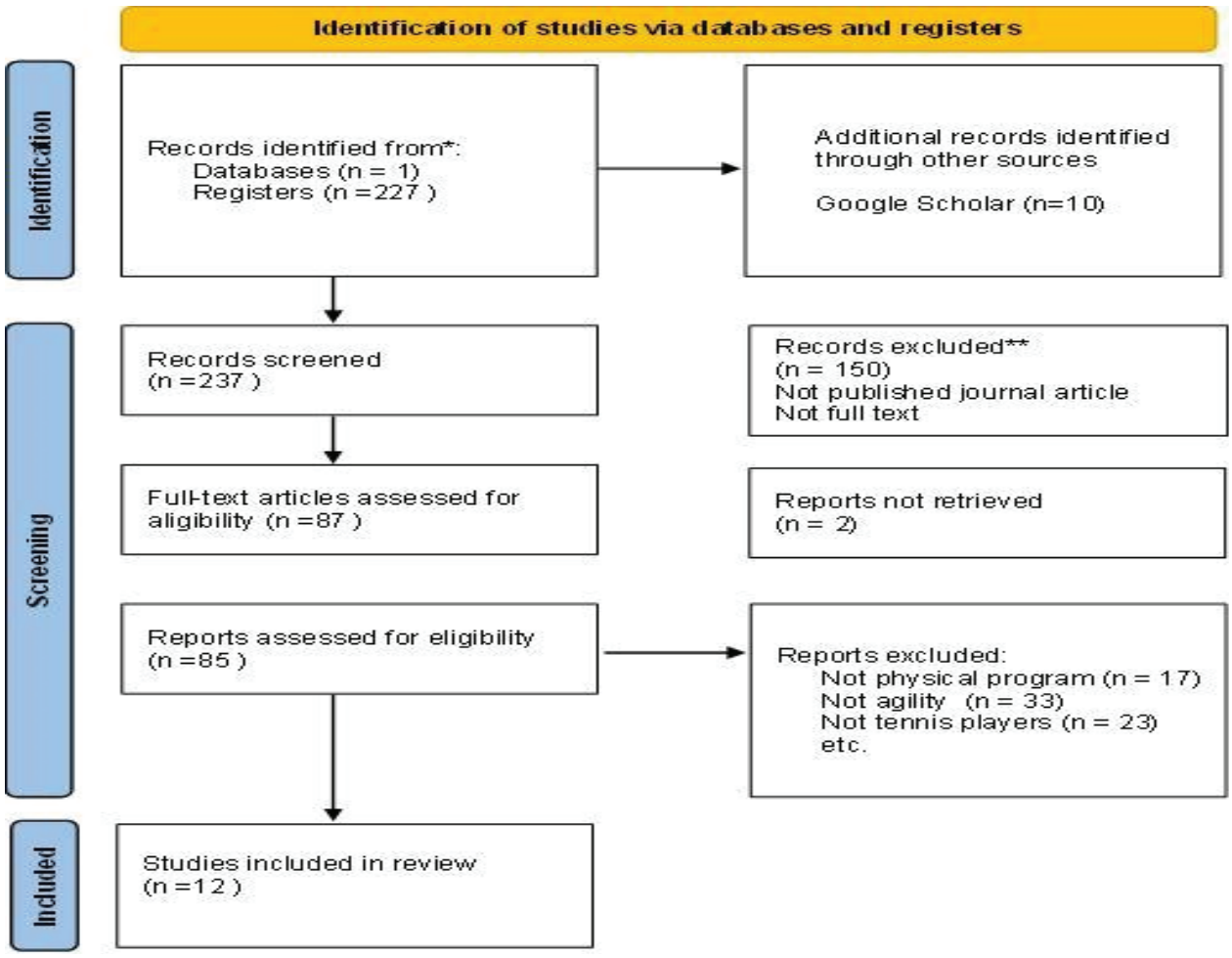
programa vežbi (intervalnog treninga visokog intenziteta, treninga tenisa na terenu, neuromišićnog zagrevanja, sportskog specifičnog treninga, pliometrijskog treninga, neuromišićnog treninga i treninga performansi). Programi vežbi su trajali od 5 - 12 nedelja sa frekvencijom od tri puta nedeljno po 45 do 90 minuta. Ovako dobijeni rezultati ukazuju na osetljiv period za razvoj agilnosti u starosnoj grupi tenisera juniora. Izdvojene su analizirane oblasti za procenu agilnosti, frontalne i lateralne agilnosti koje se mogu uočiti na osnovu testova procene agilnosti.

Introduction

Tennis is sport played by over 75 million participants worldwide (Pluim et al., 2007). Tennis is currently one of the most popular sports in the world, and many young people are encouraged to pursue it professionally (Hernández-Davo et al., 2021). In order to be effective and competitive, tennis players require a mix of speed, agility, and power, as well as highly developed aerobic fitness (Fernandez-Fernandez et al., 2009). Agility is defined as a fast whole-body movement with a change in speed or direction in response to a stimulus in physical ability (Jansen et al., 2021).

Initial acceleration is equal to the first 10 meters of a sprint, while agility is defined as the capacity to change direction quickly during points. Furthermore, frequent agility training helps athletes improve their response to stimuli and quickly contract muscles, which increases their ability to redirect in a new direction (Sheppard & Young, 2006). Agility is a crucial skill for tennis players. To be effective in rallies, players must respond to the ball and/or the opponent's position with quick, multidirectional movements (Miller et al., 2001). To be representative in monitoring agility performance, a test should capture combined physical and cognitive agility performance (Munivrana et al., 2015). Due to the specificity of the movements that are represented during the tennis game, which are almost always performed at the maximum speed and with constant changes in the direction of movement, agility is an extremely important segment of motor skills that is enhanced during fitness training (Jansen et al., 2021). Agility is a genetically

Figure 1 *PRISMA flow diagram*



highly predisposed basic motor ability that, within its latent phases of manifestation with adequate action of exercises, has the possibility of using its full potential. The latent period for the development of agility in tennis players coincides with the age category of juniors (Hernández-Davo et al., 2021).

The aim of this study was to analyze the effects of different exercise programs on the development of agility in tennis players.

Method

Data Sources and Research

This study was conducted according to the PRISMA statement (Moher et al., 2009). We conducted a systematic search between 1 June and 30 June 2022, allowing us to include all publications on the effects of agility on tennis players. The search was conducted in one main database: (PubMed). The literature was searched by the title, using the predefined combination of the following keywords: (tennis) AND (agility OR change of direction OR speed)

Results

Table 1. *Participants, variables, interventions and results of included studies*

First author and year of ublication	Participants	A	G	Duration of intervention	Type for interventio n	PF	Tests	Results
Barber-Westin et al. (2015)	42	14±2	F-31 M-11	6 weeks 3 times a week	NPT	agility	OCS,SBSAT,BSAFB (stopwatch)	Agility ↑
Barber-Westin et al. (2010)	15	13±1.5	F-10 M-5	6 weeks 3 times a week TT-1,5h	NPT	agility	OCS, SBSAT, BSAFB (stopwatch)	Agility ↑
Bashir et al. (2019)	30	15.3±0.8	/	5 weeks		agility	t-test (stopwatch)	Agility ↑
Yildiz et al. (2018)	28	9.6±0.73	M-28	8 weeks, 3 times a week, TT-45 min		agility	t-test (photocells)	Agility ↑
Kilit et al. (2019)	26	13.4±0.3	M-26	11 trainings		agility	T-drill test (electronic timing gates)	Agility ↑
Kilit&Arslsan (2018)	29	13.8±0.4	M-29	12 weeks	OTT, HIIT	agility	t-drill agility test (stopwatch)	Agility ↑
Vaghela&Parmar (2013)	36	12-18	M-36	6 days	DS	agility	Tennis specific agility test (stopwatch)	Agility ↑
Fernandez et al. (2018)	16	12.9±0.4	M-16	5 weeks	PLT	agility	Modified 5-0-5 agility test	Agility ↑
Fernandez et al. (2020)	29	15.09±1.16	M-29	8 weeks	NWU	agility	Modified 5-0-5 Change of Direction test	Agility ↓
Murphy et al. (2015)	30	M-17.3±1.4 F-16.5±0.9	M-20 F-10	8 weeks		agility	modified 5-0-5 agility test	Agility ↓
Fernandez et al. (2016)	60	12.5±0.3	M-60	8 weeks	PLT	agility	modified 505 agility test	Agility ↑
Fernandez et al. (2016)	20	14.8±0.1	/	8 weeks	HIT, SSDT	agility	505 agility test	Agility ↓

Legend: ↑ - asignificant improvement, ↓ - no significant improvement, **M** - male participants, **F** - female participants, **N** - number of participants, **G** - gender, **A** - age, **OCS** - one court suicide, **SBSAT** - service box speed and agility test, **BSAFB** - baseline speed and agility forehand and backhand, **HIIT** - high-intensity interval training, **OTT** - on-court tennis training, **NWU** - neuromuscular warm-up, **SSDT** - sport-specific drill training, **PLT** - plyometric training, **TT** - training time, **DS** - dynamic stretching, **NPT** - neuromuscular and performance training

AND (program OR HIIT OR test) AND (category of juniors). We also searched Google Scholar and the reference list of the selected studies for additional literature that may not have been included in the search results in the PubMed database.

Study Selection and Data Extraction

Figure 1 shows the study selection process. This study identified 237 articles through the selected database search and the results are the following: PubMed (n = 227), and additional articles were identified through Google Scholar (n = 10). After deleting 150 articles due to the unavailability of full text and published articles, the remaining 87 articles were read. After articles were assessed for eligibility, two reports were not retrieved. After the final exclusion (not physical program, not agility, not tennis player category of juniors) 12 studies were included in the review. Table 1 contains an overview of papers dealing with the effects of exercise programs on tennis players in the junior category. By analyzing the table, it can be seen that the works are presented and analyzed through nine groups of parameters: reference, the age of subjects, the sex of subjects, the number of subjects, the duration of the program, the name of the program, monitored motor skills, the instruments used to assess motor skills and the results achieved after the exercises. The papers included between 15 (Barber-Westin et al., 2010) and 60 respondents (Fernandez-Fernandez et al., 2016), also the respondents were male and female (Barber-Westin et al., 2010; Murphy et al., 2015) or only male (Fernandez-Fernandez et al., 2016, 2020; Fernandez-Fernandez et al., 2017; Kilit et al., 2019; Kilit&Arslan, 2018; Vaghela&Parmar, 2013; Yildiz et al., 2019) and female gender (Barber-Westin et al., 2010; Murphy et al., 2015). In all papers, the motor ability, agility, was tested as one of the assessed abilities. The exercise programs lasted from a minimum of 5 weeks (Bashir et al., 2019; Fernandez-Fernandez et al., 2017) to a maximum of 12 weeks (Kilit&Arslan, 2018) with a weekly frequency of 3 times (Barber-Westin et al., 2010; Yildiz et al., 2019) and the duration of individual training from a minimum of 45 min (Yildiz et al., 2019) to a maximum of 90 min (Barber-Westin et al., 2010). The tests used to assess agility in tennis players of the junior category were the t-test (Bashir et al., 2019; Kilit et al., 2019; Kilit&Arslan, 2018; Yildiz et al., 2019), modified 505 (Fernandez-Fernandez et al., 2016, 2020; Fernandez-Fernandez et al., 2017; Murphy et al., 2015) with the help of photocell instruments (Kilit et al., 2019; Yildiz et al., 2019) and a stopwatch (Barber-Westin et al., 2010; Bashir et al., 2019; Kilit&Arslan, 2018; Yildiz et al., 2019). The articles in which statistically significant effects were achieved after the applied exercise program are (Barber-Westin et al., 2010; Bashir et al., 2019; Fernandez-Fernandez et al., 2016, 2018; Vaghela&Parmar, 2013; Yildiz et al., 2019) while in the papers (Fernandez-Fernandez et al., 2016, 2020; Murphy et al., 2015) no statistically significant effects of the program were achieved in junior tennis players. In accordance with the results of the analyzed works, it can be observed that the tests for the assessment of agility in tennis players of the junior category do not differ in relation to gender. Furthermore, specific exercise programs were applied to the members of both sexes. According to the results, an exercise program (plyometric training, dynamic stretching, neuromuscular training, ability training, and high-intensity interval training) can be recommended for the development of agility in tennis players of both sexes. The optimal duration of the program would be from five to eight weeks with a weekly frequency of three times and the duration of the training process 45 min to 90 min.

Discussion

The objective of this systematic review was to assess the effects of different training programs on the development of agility in tennis players. Agility is considered to be an important motor ability since the tennis game contains a high percentage of change of direction movements. Fourteen intervention studies focused on improving the development of agility among young players. Major findings of this systematic review showed that most of the studies that included different types of interventions enhanced agility performance. These findings have significant practical implications that can be used as a successful method for increasing agility performance in tennis players.

Plyometric training was shown to be an effective method for improving agility performance (Asadi et al., 2017; Little& Williams, 2005). Fernandez-Fernandez et al. (2018) showed that plyometric training can be used for a short-term (5 weeks) intervention program with a significant improvement in agility. The results of the study (Fernandez-Fernandez et al., 2016), relative to standard tennis training, show that the combination of PT to regular tennis training appears to be an adequate stimulus for developing physical abilities in young tennis players. There is proof that plyometric training is beneficial for agility due to the explosive power in jumps and is closely related to the short changes of direction. The effects of dynamic stretching have been shown to improve performance by allowing for an optimal switch from the eccentric to the concentric muscle contraction needed to produce fast running speeds. It was a short program of only six days that contributed to the improvement of agility in tennis players (Vaghela&Parmar, 2013). In tennis, there are periods of low-intensity action interwoven with periodic high-intensity attempts, active recuperation between points, and inactive moments between changeover pauses in play and HIIT. The study (Fernandez-Fernandez et al., 2012) showed positive effects on the development of agility among young tennis players. Programs HIIT and program on-court tennis training study (Kilit&Arslan, 2018) showed that both training approaches can help young tennis players improve their anaerobic and aerobic fitness parameters such as VO2 max, sprinting, and jumping. Tennis-specific OTT may be a more efficient training technique for enhancing techni-

cal proficiency and agility in young tennis players, whereas HIIT is better employed for speed-based conditioning.

The main limitation of this review was the dissimilarity between tests and programs presented in articles for evaluating agility. Furthermore, the participants of the analyzed studies were not homogeneous. They included male and female participants of different ages.

Conclusion

Based on the results of the analyzed research, it can be concluded that agility is a rather complex field and a very important factor for tennis players in junior categories. The results showed that the effect is statistically significant after each exercise program due to the sensitive period for the development of agility in this age group. Also, due to the sensitive period for the development of this motor skill, a statistically significant improvement occurs in a very short time interval. The analyzed areas of agility assessment were singled out such as frontal and lateral agility observed on the basis of agility assessment tests. The tests were exclusively reactive. The scope of reviewed papers indicates a small amount of information derived from scientific research that deals with the effects of training programs on the development of agility in junior tennis players, which points researchers to greater involvement in the future in this particular field.

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