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# Physiological and performance effects of high-intensity interval training in tennis players: A systematic review

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**ABSTRACT**

The purpose of this systematic review was to overview the physiological and performance effects of high-intensity interval training (HIIT) in tennis players. Searches for this review were performed by using four electronic databases: Web of Science, Scopus, SPORTDiscus with Full-Text, and PubMed. Intervention studies investigating the effects of HIIT on tennis players were searched from inception to December 29th, 2021. Seven studies met all inclusion criteria and were included in the study. The findings revealed that tennis players who participated in HIIT interventions had improved their aerobic capacity and tennis performance. Fluctuating results were reported for agility, sprint, and jump performances. In conclusion, the results of the review may suggest that HIIT is beneficial for tennis players to achieve improvement in cardiorespiratory fitness and technical abilities regardless of age, gender, and competitive level.

**Key words:** Repeated sprint ability; speed endurance training; controlled trial; cardiorespiratory fitness.

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## INTRODUCTION

High-intensity interval training (HIIT) is a training protocol that involves short periods of intense exertion followed by brief recovery periods or low-intensity activity (Billat, 2001; Buchheit & Laursen, 2013; Gibala et al., 2012; Gillen & Gibala, 2014; Ross et al., 2016; Bishop et al., 2019). When compared to sedentary (non-exercising) or moderate-intensity groups, HIIT is effective in strengthening cardiorespiratory fitness, aerobic capacity, and body composition (Buchan et al., 2011; Costigan et al., 2015; Kessler et al., 2012; Laursen & Jenkins, 2002; Logan et al., 2014; Sawyer et al., 2020; Sperlich et al., 2011). An increasing body of research shows that HIIT can be an excellent option instead of conventional endurance training, resulting in similar or even better physiological outcomes in healthy individuals compared to a matched-work basis which is still one of the methods of comparisons prevalently used to evaluate the efficacy of HIIT vs. continuous training, as the study by MacInnis et al. (2016) testifies (Hwang et al., 2011; Tjønna et al., 2009; Wisløff et al., 2007). HIIT is recognized as a time-efficient training method based on several physiological, performance-related, and health-related criteria because of its similar or even superior adaptations compared to regular moderate-intensity continuous training (Babraj et al., 2009; Burgomaster et al., 2005; Gibala et al., 2006; Jakeman et al., 2012; Wewege et al., 2017).

Tennis includes high efforts combined with periods of low-intensity activity, with active (between two points) and passive recovery periods (between the games) occurring during a match based on the literature review which often

lasts longer than an hour and, in some cases, more than five hours (Christmass et al., 1998; Fernandez-Fernandez et al., 2009; Kovacs, 2007; Smekal et al., 2001). Competitive tennis players in this situation require a combination of fitness traits such as speed, agility, power, and well-developed aerobic fitness to accomplish high-performance levels (Kovacs, 2007; Ferrauti et al., 2011; Mero et al., 1991). During match play, demands alternate between replacing energy sources and restoring balance in the body during intervals of high-intensity activities such as change of directions, acceleration and decelerations through intramuscular phosphates and glycolysis, and energy requirement for rounds of high-intensity activities through intramuscular phosphates (Glaister, 2005; Smekal et al., 2001; Spencer et al., 2005). As a result, it appears that professional players' training should concentrate on developing their capacity to complete high-intensity exercises frequently while recovering quickly (Glaister, 2005; Kovacs, 2007). That is why tennis training should incorporate aerobic and anaerobic physical activity.

Tennis requires players to repeatedly generate powerful strokes and rapid movements on the court for a long period of time; therefore, to meet and endure these challenging physiological conditions, modern-day players need a mixture of fitness qualities such as speed, agility, and power combined with well-developed aerobic fitness (Girard et al., 2015; Kovacs, 2007). Thus, developing the capacity to successfully endure high-intensity activities and recover quickly from them, known as repeated-sprint ability or RSA, can provide competitive advantages for players (Girard et al., 2015). To achieve this goal, one option that coaches frequently use is repeated straight-ahead sprint patterns as a streamlined, pre-planned "on-court" or "off-court" high-intensity run on the field (Bishop et al., 2011).

In practice, since young tennis players spend a lot of time on technical and tactical drills, not enough time is dedicated to increasing their aerobic fitness (Crespo & Miley, 1998). To improve aerobic performance, HIIT integrated into game-specific on-court exercises has been advised (Kilit et al., 2018). Such a session aims to preserve technical skills while minimizing training time (Fernandez-Fernandez et al., 2001; Fernandez-Fernandez et al., 2012). However, evidence suggests that while dedicated playing HIIT sessions may meet aerobic goals in cardiac requirements, they might also cause groundstroke velocity- and accuracy-related technical issues in young tennis players (Pialoux et al., 2015).

There are already studies on the effects of HIIT and sports-specific training programs in team sports, mainly soccer (Hill-Haas et al., 2009; Impellizzeri et al., 2006; Sperlich et al., 2011). Yet, to the best of the authors' knowledge, no systematic review has been conducted to investigate the effects of HIIT in tennis. Therefore, the purpose of this study was to overview the physiological and performance influences of HIIT on tennis players.

## METHODOLOGY

In the present systematic review, a literature search was performed to maintain the articles focusing on the effects of HIIT in tennis. PRISMA statement (Page et al., 2021) formed the basis of the study and report. Searching procedures are completed for all relevant articles on Dec 29, 2021. Four electronic databases were used. These included the Web of Science Core Collection, which contains a vast collection of literature on science, technology, and social sciences. Another database was Scopus, which is a multidisciplinary database with over 18,000 peer-reviewed periodicals covering a wide range of subjects. SPORTDiscus with Full-Text was another database that provided comprehensive coverage of sports-related literature. The last database was PubMed, which is a database comprising over 35 million citations for biomedical literature from MEDLINE, life science journals, and online books. The Boolean searching strategy was preferred to achieve the full potential of the search engines mentioned above. It was aimed to form a keyword set that covers the articles in sports focusing on tennis. The following keyword structure was set: "tennis" AND ("high-intensity interval training" OR "HIIT" OR "high-intensity intermittent training" OR "interval training" OR "sprint interval training" OR "repeated sprint training" OR "speed endurance training").

Studies were included if (1) they were intervention studies (randomized-controlled or non-randomized-controlled trials); (2) they were conducted with tennis players with no restriction of the duration of the intervention, age, and competition level; (3) HIIT was the focus of the study; (4) they were original articles; (5) they were published in English. Studies were excluded if (1) they were cross-sectional studies; (2) were not conducted with tennis players; (3) used HIIT intervention along with other training methods; (4) were not original articles; (5) were not published in English. Two authors (DD and HO) independently removed duplicates and applied inclusion/exclusion criteria phases. Regarding the criteria application phase outcomes, reviewer disagreements were discussed and solved before finalization.

The Critical Review Form Qualitative Studies (Law et al., 1998) was used to assess the quality of the applied methodology in the included articles. This tool can be used to determine a wide range of qualitative investigations. The following areas were utilized to assess each article: journal level, the aim of the study, background information on the topic, study design, sample group, study outcomes, data analysis methods, findings, conclusion, and implications for future research (Table 1). These questions were scored 1 (meets the criterion) or 0 (does not match the requirements). Total scores for each article out of 15 points were calculated, as 0 point for Not Registered (NR), in which no information was given on the validity and reliability of the instruments employed in the study. The methodological quality of the assessed studies is presented in Table 1. A total score of fewer than seven points indicated low, from seven to ten points indicated good, and eleven points or more indicated high quality (Van der Fels et al., 2015). Two authors independently evaluated the quality of the included studies. Only around 5% of the time, the researchers disagreed about the results. When a discrepancy occurred in the methodological quality of the study, a consensus on the study was reached by reevaluation.

109 studies were attained from the above-mentioned databases (Figure 1). After manually removing duplicate studies (n = 52), 57 studies were obtained for the title and abstract reading. After the title and abstract reading of the studies, 25 full-text articles were evaluated for eligibility. 18 of the 25 articles were excluded as they were not intervention studies (n = 8), were not conducted with tennis players (n = 2), or combined HIIT with other training methods (n = 8). Finally, 7 studies examining the effects of HIIT interventions in tennis were included.

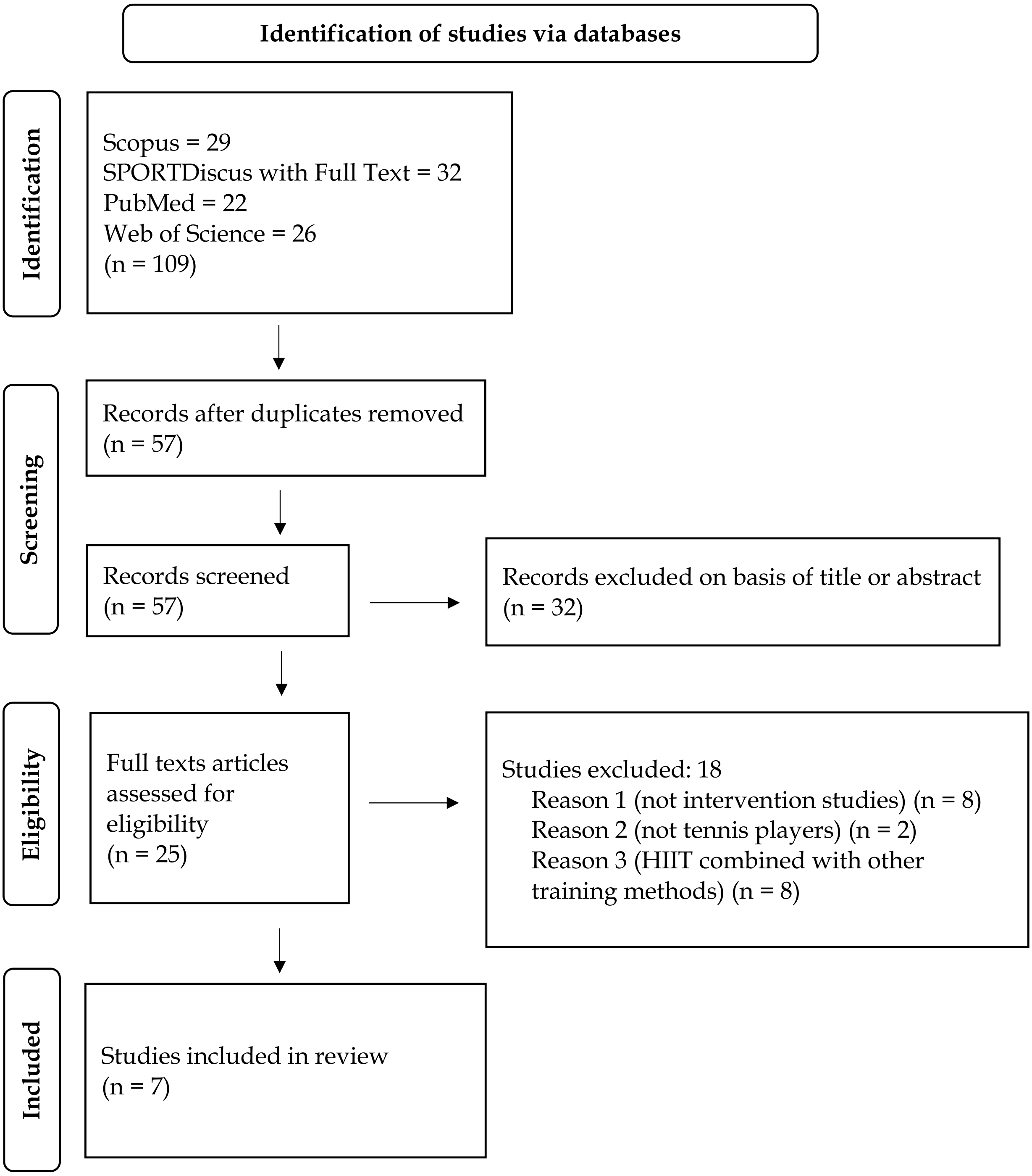


**Figure 1.** *Flow chart showing identification of studies selected for systematic review*

## RESULTS

Table 1 summarizes the overall quality assessments of the studies by using the Critical Review Form - Quantitative Studies (Law et al., 1998). The review included seven studies from the HIIT category. Except for one study (Girard et al., 2015), they were all of high methodological quality. Six studies received 11 to 15 points, with two receiving 15 points (Table 1). The following are the most notable outcomes: Four of the seven studies failed to justify the sample size (item 7), and three failed to report study limitations (item 15). All studies met the criteria and received one point for the first, third, fourth, fifth, eighth, eleventh, and thirteenth items. There was only one study for the ninth item and four for the tenth item. Finally, for the 15th item, four studies met the criteria. Even though six studies had high methodological quality, only two received a total score of 15 on the Critical Review Form - Quantitative Studies. All studies, apart from one (Fernandez et al., 2012), were published after 2015.

**Table 1**

*The methodological quality of the reviewed articles [a].*

| | Question Number [b] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Author (Year)* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Total |
| Brechbuhl et al. (2018) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 14 |
| Brechbuhl et al. (2020) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 15 |
| Fernandez et al. (2012) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NR | 1 | 1 | 1 | 1 | 0 | 13 |
| Fernandez et al. (2017) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | NR | 1 | 1 | 1 | 0 | 0 | 11 |
| Girard et al. (2015) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | NR | NR | 1 | 0 | 1 | 0 | 1 | 9 |
| Kilit et al. (2018) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 15 |
| Wiewelhove et al. (2016) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | NR | 1 | 1 | 1 | 1 | 0 | 12 |

**Only the first author is mentioned; NR = not registered; a 1 = meet criteria; 0 = does not meet criteria; b (1) The study is published in a peer-reviewed journal or book. (2) The study is published in an indexed journal. (3) Was the aim of the study stated clearly? (4) Was relevant background literature reviewed? (5) Was the design appropriate for the research question? (6) Was the sample described in detail? (7) Was the sample size justified? (8) Was informed consent obtained? (9) Were the outcome measures reliable? (10) Were the outcome measures valid? (11) Were results reported in terms of statistical significance? (12) Was practical importance reported? (13) Were conclusions appropriate given the study findings? (14) Are there any implications for future research given the results of the study? (15) Were limitations of the study acknowledged and described by the authors?*

Table 2 provides a review of the included studies and the effects of HIIT programs in the included studies. It contains information about the author, study design, sample, intervention, and results. Three of the seven investigations were controlled, while the other four were not.

Analysis of the studies revealed that three of the seven studies were conducted with competitive-level tennis players (Fernandez et al., 2012; Girard et al., 2015; Wiewelhove, 2016), three with well-trained players (Brechbuhl et al., 2018; Brechbuhl et al., 2020; Fernandez et al., 2017), and one with intermediate players (Kilit et al., 2018). Fernandez et al. (2012) had the most participants of the seven research, with 31 competitive male players. On the other hand, Wiewelhove et al. (2016) had the fewest participants, with only 8 competitive male junior players. Girard et al. (2015) had the youngest participants, with a mean age of 12.8, whereas Brechbuhl et al. (2020) had the oldest individuals, with a mean age of 28.8 ± 5.9. Three studies (Fernandez et al., 2012; Kilit et al., 2018; Wiewelhove, 2016) contained solely male participants, while two studies (Fernandez et al., 2017; Girard et al., 2015) did not state the gender of the final sample.

Brechbuhl et al. (2018) compared repeated sprint trainings (RST) in normobaric hypoxia versus normoxia. This study revealed performance improvements in total time to exhaustion scores ($p < 0.01$, $\eta 2 = 0.01$) in both groups, while aerobic capacity remained unchanged after the intervention. Brechbuhl et al. (2018) reported no significant improvement in repeated sprint ability (RSA) performance following intervention in both groups in their study. They reported that only players who participated in RST in normoxic conditions improved significantly in terms of ball accuracy ($p < 0.01$) and tennis performance index ($p < 0.05$).

In another study, Brechbuhl et al. (2020) compared the short- (the week after intervention) and long-term (3 weeks after Post-1) effects of RST in hypoxia vs. normoxia in competitive tennis players. They revealed performance increases in total time to exhaustion scores ($p < 0.001$) in both hypoxia and normoxia groups, while VO2max remained unchanged after intervention in both groups. Brechbuhl et al. (2020) found significant improvements in the total duration of RSA at Post-1 and Post-2 in the RSH group compared to the pretest. Their results revealed no significant time or interaction effect for heart rate variability.

Fernandez et al. (2012) compared the physiological and performance effects of HIIT and RST in competitive tennis players. Both training methods similarly improved overall aerobic fitness. Their results revealed improvements in VO2peak of 4.9% for RST and 6.0% for HIIT. In contrast, no changes were observed in the control group. Fernandez et al. (2012) reported no increase in jumping or running ability for none of the training methods. Similarly, no differences in 20-m sprint time were reported from the pretest to the posttest. Their findings revealed significant improvements in the RSA mean time. After the intervention, the mean time during the RSA test significantly reduced in the RST; however, no significant differences were reported for the HIIT and control group between the pretest and posttest.

In a similar study conducted with young tennis players, Fernandez et al. (2017) analyzed the influence of HIIT combined with sport-specific drill training (MT) and sport-specific drill training alone (DT) on fitness parameters. Pre- and post-training testing revealed that both groups improved significantly in VO2peak and velocity obtained in the intermittent fitness test (IFT). Fernandez et al. (2017) observed no changes in the remaining variables following the training session. Furthermore, there were no changes between DT and MT after training. Their results showed no significant differences between training groups in terms of the rate of perceived exertion.

Girard et al. (2015) compared repeated maximum unidirectional- and shuttles-sprint trainings in terms of physical tennis performance indicators in 15 competitive teenage players. None of the physical performance indicators in their study showed a major effect of group or any significant interaction between time and group. The Control group had a 3% improvement in performance. However, the unidirectional group outperformed the shuttles group in terms of tennis-specific endurance (Hit & Run Tennis Test). Girard et al. (2015) discovered that both the unidirectional and the shuttles groups significantly improved their isolated (linear 20-m sprint) and repeated-sprint performance, indicating that repeated-sprint training with or without direction change

**Table 2**

*Summary table of studies included for the review.*

| Study | Participants | Design | HIIT Format | Intervention | Measures | Results |
|---|---|---|---|---|---|---|
| Brechbuhl et al. (2018) | 18 well-trained players (16 males and 2 females) between the ages of 18 to 35 years | Non-controlled | Repeated-sprint training in normoxic and hypoxic conditions | 12 days, 5 sessions, ~60 minutes | - RSA<br>- TEST<br>- AC<br>- TP | - RSA: remained unchanged after intervention in both groups.<br>- TEST: significantly improved ($p < 0.01$) in both groups.<br>- AC: remained unchanged after intervention in both groups.<br>- TP: ball accuracy ($p < 0.01$) and tennis performance index ($p < 0.05$) improved significantly in only players who participated in repeated sprint training in normoxic condition (RSN). |
| Brechbuhl et al. (2020) | 30 well-trained players (RSH n = 11, RSN n = 11, Control n = 8) 28.8 ± 5.9 years old | Controlled | Repeated-sprint training in normoxic and hypoxic conditions | 12 days, 5 sessions, ~60 minutes | - RSA<br>- TEST<br>- HRV<br>- AC | - RSA: Compared to Pre, RSA total time increased significantly at Post-1 and Post-2 (-1.9 and -2.5%, $p < 0.05$) in repeated sprint training in hypoxic condition (RSH) only.<br>- TEST: From Pre to Post-1 and Post-2, RSH improved TEST time to exhaustion (+18.2 and +17.3%; both $p < 0.001$). Markers of TEST performance did not change for both RSN and the control group (CON).<br>-HRV: Did not change in either supine or standing positions.<br>-AC: There was a significant interaction between time and group for total time to exhaustion (TTE) ($p < = 0.05$). Compared to Pre, TTE increased at Post-1 (C18.3%, $p < 0.001$, d = 0.97) and Post-2 (C17.3%, $p < 0.001$, d = 0.97) in RSH, with no change in RSN and CON. |
| Fernandez et al. (2012) | 31 competitive male players (HIIT n = 11, RST n = 12, CON n = 9) HIIT= 22.6 ± 4.8 years old RST= 21.2 ±5.1 years old CON= 22.1 ±3.3 years old | Controlled | HIIT= 3X (3 X 90 seconds, 90–95% HRmax), with 3-minute rest<br><br>RST= 3 X (10 X 5-second) shuttle sprints, with 20-second rest between repetitions, 3 minutes between sets | 6 weeks, 18 sessions | - RSA<br>- AC<br>- HTT<br>- CMJ<br>- 20-m ST | - RSA: The mean time during the RSA test was significantly reduced in the repeated sprint training (RST) (3.8%; $p = 0.000$) after the intervention, whereas there were no differences between the pretest and posttest for the HIIT ($p = 0.951$) and CON ($p = 0.541$).<br>- AC: Both groups induced similar significant increases in the VO2peak level (HIIT: 6%, $p = 0.008$; RST: 4.9%, $p = 0.010$) whereas no changes occurred in CON.<br>- HTT: Both the RST and HIIT groups showed a significant improvement in their maximum level achieved during the HTT from the pretest to the posttest. The RST group saw an increase of 14.5% (with a significance level of $p = 0.014$) and the HIIT group had a much larger increase of 28.9% (with a significance level of $p = 0.000$). Furthermore, the post-training values for the HIIT group were significantly higher than those of the RST group (with a significance level of $p = 0.010$). On the other hand, the players from the CON group only experienced a small increase of 2.4% (with a non-significant significance level of $p = 0.549$).<br>- CMJ and 20-m ST: The training protocols, HIIT and RST, had no effect on the CMJ performance and 20-meter ST. Additionally, there was no significant change observed in the performance of the CMJ and 20-meter ST for both groups from the pre-test to the post-test. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fernandez et al. (2017) | 20 well-trained players<br>14.8 ± 0.1 years old<br>DT (drill training) = 10<br>MT (HIIT combined with sport-specific drill training) = 10 | Non-controlled | Mixed high-intensity intermittent runs | 8 weeks,<br>16 sessions,<br>68.9 ± 12.7 minutes | - AC<br>- 30-15 IFT<br>- AT<br>- CMJ<br>- ST<br>- RPE | - AC: After the training period, there were significant improvements in VO2peak in both drill training alone (DT) and HIIT combined with sport-specific drill training (MT) groups (DT 2.4%, ES = moderate; MT 4.2%, ES = large).<br>- 30-15 IFT: After the training period there were significant improvements in velocity obtained in the intermittent fitness test (IFT) (DT 2.2%, ES = small; MT 6.3%, ES = large) in both groups.<br>- AT – CMJ - ST: After the training period neither of the training programs led to significant improvements in speed/agility (5- to 20-m sprint, 505 test) or explosive power (CMJ).<br>- RPE: No differences were found between training groups regarding the rate of perceived exertion (RPE) (6.4 ± 1.1 vs 7.2 ± 1.3 for DT and MT, respectively). |
| Girard (2015) | 15 competitive teenage players<br>Unidirectional Group: 12.8 ± 1.6 years old<br>Shuttles Group: 13.6 ± 1.5 years old<br>CON: 13.6 ± 1.5 years old | Controlled | Unidirectional repeated sprint training and shuttles repeated sprint training | 5 weeks,<br>10 sessions,<br>~60 minutes | - HRTT<br>- 20-m ST<br>- AT<br>- RSA<br>- CMJ | - There was no significant difference found in any of the physical performance variables between the groups or any significant change in the variables over time based on the group.<br>- The Unidirectional Group showed twice as much improvement in tennis-specific endurance, as measured by the Hit & Run Tennis Test (HRTT), compared to the Shuttles Group.<br>- The performance improvement in the linear 20-meter sprint, agility, shuttles repeated-sprint ability test, and CMJ tests was 2-3 times greater with the Shuttles Group compared to the Unidirectional Group. |
| Kilit and Arslan (2018) | 29 intermediate level male players<br>13.8 ± 0.4 years old | Non-controlled | LiHIIT | 6 weeks,<br>16 sessions,<br>Total 203 minutes. | - AC<br>- JT<br>- ST<br>- AT<br>- TP | - AC: Significant changes were observed in VO2max responses in both the HIIT and on-court tennis training (OTT) groups (HIIT: +5.2%, $p < 0.05$, $d = 1.36$; OTT: +5.5%, $p < 0.05$, $d = 1.50$).<br>- JT - ST: Sprinting (20 m with 5- and 10-m splits) and jumping (CMJ, SJ, and DJ) performances improved in both groups from pre-test to post-test ($p < 0.05$, d ranging from 0.40 to 1.10). The 400-m running test time decreased significantly from pre-testing to post-testing in the HIIT (24.9%, $p < 0.05$, $d = 1.32$) and OTT groups (22.2%, $p < 0.05$, $d = 0.60$).<br>- AT: OTT group showed significantly higher performance responses after test than before test (27.0%, $p < 0.05$, $d = 0.88$).<br>- TP: OTT group had significantly higher performance responses in terms of technical scores (+10.7%, $p < 0.05$, $d = 0.77$). |
| Wiewelhove (2016) | 8 competitive male junior players<br>15.1 ± 1.4 years old | Non-controlled | SiHIIT | 14 sessions in 2 four-day periods separated by 4 months | - CMJ<br>- CKA<br>- BLC | - BLC: In both recovery interventions, lactate concentration was significantly increased immediately after training ($p = .001$), and significantly decreased immediately after the recovery intervention ($p = .001$).<br>- CMJ and DOMS: The HIIT microcycle induced a significant decrease in CMJ height and a significant increase in DOMS in both recovery interventions.<br>- PR and Stress: The perceived recovery decreased, and perceived stress increased significantly between testing days in both interventions.<br>- CKA: The Creatine Kinase activity was not significantly different after the microcycle, compared with the baseline values, in the active recovery and passive recovery intervention. |

will help players get quicker. Following the shuttles group, performance enhancements for the linear 20-m sprint, agility, shuttles repeated-sprint ability test, and CMJ tests were greater (2-3 fold) than following the unidirectional group.

Kilit et al. (2018) compared HIIT and on-court tennis training (OTT) on young tennis players in terms of psychophysiological and performance responses, and technical ability. They observed significant changes in VO2max responses in both groups. Kilit et al. (2018) found that the OTT group had significantly greater performance outcomes in terms of technical ability.

Wiewelhove (2016) evaluated the effect of repeated use of active recovery on fatigue markers throughout a 4-day shock microcycle with 7 HIIT sessions. They found that the HIIT shock microcycle significantly reduced counter movement jump performance. Wiewelhove (2016) observed that the HIIT shock microcycle led to a significant decrease in perceived recovery, in addition to a moderate to significant increase in creatine kinase levels, delayed-onset muscle soreness, and perceived stress, compared to the scores before the training program.

## DISCUSSION

This systematic review investigated the effects of HIIT interventions in tennis players. The main findings of the review are the following: HIIT interventions have significant beneficial effects on cardiorespiratory fitness in tennis regardless of age, gender, and competitive level; structured on-court HIIT exercises are more effective than off-court HIIT training in terms of technical ability; no adverse effect was detected related to HIIT intervention, so it turns out to be a safe and practical alternative to improve tennis performance.

The effects of HIIT related to tennis performance have been attracting the attention of researchers increasingly in recent years because HIIT is a time-efficient training strategy in addition to its undeniable performance effects (Babraj et al., 2009; Burgomaster et al., 2005; Gibala et al., 2006; Jakeman et al., 2012; Wewege et al., 2017). Consistent with the literature, the findings of this review revealed that players in HIIT intervention groups have significant improvements in functional capacities compared to the players in control groups (Brechbuhl et al., 2018; Brechbuhl et al., 2020; Fernandez et al., 2012; Fernandez et al.; Girard et al., 2015; Kilit et al., 2018; Wievelhowe, 2016). To this date, few studies investigated the effects of HIIT interventions on fatigue in tennis players. In their study with competition-level male tennis players, Suárez Rodríguez & del Valle Soto (2017) found that reduced fatigue levels and higher precision in specific tennis-related exercises were achieved. However, in contrast with Suárez Rodríguez & del Valle Soto (2017), Wiewelhove et al. (2016) indicated that HIIT had no effect on exercise-induced fatigue.

The findings of this review showed that HIIT intervention overall has positive effects on physical performances in tennis players. Nevertheless, when specific interval types are observed, this review indicates that tennis players may benefit more from practicing using on-court tennis-specific drills to improve their technical abilities (Fernandez et al., 2017; Kilit et al., 2018). Overall, based on the findings of the review, a HIIT strategy, especially on-court approaches, could be an effective way to develop a more significant physiological demand since an on-court approach has a more crucial effect

on stroke performance than an off-court program; thus, this intervention should be well-integrated into periodization programs of tennis players.

This systematic review may have practical implications for coaches. The findings of the included studies confirmed the effectiveness of HIIT interventions in developing the aerobic capacity of tennis players; therefore, HIIT-integrated exercise programs could help improve players' cardiorespiratory fitness levels. In addition, studies including specific interval programs confirmed the effectiveness of on-court HIIT interventions on players' technical ability and stroke performance; therefore, coaches can benefit from HIIT strategies and programs mentioned in the included studies as tools to give tennis players a competitive edge. This systematic review is subject to one main limitation. Although very general keywords were selected and the exclusion criteria were not too strict, a small number of articles were attained as a result of searching four databases. Therefore, the number of searched databases and languages should be higher to maximize the study's comprehensiveness and reliability.

## CONCLUSION

In conclusion, this review aimed to analyze the influence of HIIT interventions in tennis. The main findings of the studies highlighted that tennis players who participated in HIIT interventions had improved their aerobic fitness and technical abilities regardless of age and competitive level which could be considered an effective tool to support players' tennis competitiveness. Another notable result was that structured HIIT exercises positively affected tennis players' technical ability and stroke performance. Since competitive tennis requires too much time to be on the court for technical and tactical skills, this systematic review suggests that structured high-intensity interval exercises could be an effective tool for coaches to improve players' performance by being a time-efficient strategy while meeting the physiological requirements of tennis.

## CONFLICT OF INTEREST AND FUNDING

The authors declare that they do not have any conflict of interest and that they did not receive any funding to conduct the research.

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