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In terms of shooting performance, exercises such as jumps and ball throws in HIIT programs enhance explosive power in both the legs and upper body (Hammami et al., 2021). This increase in strength and stability is crucial for consistent and powerful shooting, particularly in dynamic game situations (Aksović et al., 2020; Candra, 2018). HIIT also improves cardiovascular efficiency, enhancing oxygen delivery to the muscles (Astorino et al., 2011). Better oxygenation helps maintain shooting form and accuracy during high-intensity periods, such as dynamic shooting drills. Regarding passing performance, HIIT involving ball throws and similar exercises improves neuromuscular coordination, leading to more accurate and quicker passing, as seen in wall passing drills (Al Kitani, 2024).

For dribbling performance, HIIT drills like high knees, burpees, and cone drills improve foot speed, agility, and coordination, which are essential for effective dribbling (Lennemann et al., 2013). These exercises develop key physical attributes that directly enhance dribbling skills in several ways. First, HIIT engages fast-twitch muscle fibres during high-intensity intervals, contributing to enhanced neuromuscular adaptations crucial for COD, essential for explosive movements and sudden directional shifts (Bucheit and Laursen, 2013). This increased neuromuscular efficiency allows players to control their bodies better and quickly adjust while dribbling (Ahmed, 2015). Additionally, drills like high knees and running back and forth improve lower body strength and coordination, leading to enhanced stability and balance (Fredericson and Moore, 2005). This stability is crucial when dribbling at high speeds or changing directions. Still, HIIT drills that involve rapid direction changes improve a player's ability to move efficiently in defensive situations (Stankovic et al., 2023). This improvement translates to better on-ball defense and the ability to stay in front of an offensive player. The endurance developed through HIIT allows players to move effectively for extended periods, which is crucial for effective defense throughout a game (Ní Chéilleachair et al., 2017).

However, two of the six included studies found no significant improvement in shooting and passing performance (Delextrat and Martinez, 2014; Zeng et al., 2022). The shooting and passing tests used in these studies, such as 60-s shooting with the rebound, 40-s jump shots, 60-s shooting with a backward run to the centre line, and two-handed chest pass tests, were comparable to those in other studies that reported significant improvements. Further research is needed to investigate the exact mechanisms by which HIIT affects shooting and passing performance. Studies with varied HIIT protocols, including adjustments in duration, intensity, and basketball-specific movements,

could provide more insight into the conditions under which HIIT enhances these technical skills.

### Limitations

Some limitations should be considered when interpreting the results. First, a few included studies did not specify whether the HIIT interventions were implemented during the pre-season, in-season, or off-season. This omission limits the ability to account for potential differences in training adaptations and recovery that might occur based on the timing of the intervention. Why is this important?

Additionally, a risk of bias analysis revealed several potential sources of bias among the included studies. For instance, some studies had inadequate blinding of participants and assessors, which may influence the outcomes reported. These biases may lead to overestimating or underestimating HIIT's effects on basketball performance. Finally, due to the limited number of available articles, the study performed no separate analyses based on age (e.g., adolescents vs. adults) or playing level (e.g., international vs. national levels). This limitation may obscure potential differences in the effectiveness of HIIT across different demographic and competitive groups.

### Conclusion

This systematic review and meta-analysis provide valuable insights into the effects of HIIT on basketball players, highlighting its potential to enhance physical fitness and basketball performance. The findings suggest that HIIT is particularly effective in improving cardiovascular endurance, power, change of direction (COD) ability, sprint performance, and basketball skill-related performance. However, the effects on some physical aspects, such as  $VO_{2max}$ , Yo-Yo IR 1, jump tests, ball throw test, 20-m COD sprint test, T-test, 20-m linear sprint, and specific basketball skills like shooting accuracy and passing, are less consistent. This variability is likely due to the need for more targeted, skill-specific training. The analysis also reveals that younger athletes (aged 15-16 years) and those undergoing in-season training might not experience the same level of benefit from HIIT as older or off-season athletes, potentially due to factors such as ongoing physical development and the cumulative fatigue associated with in-season play.

### Practical implications

Coaches and trainers looking to implement HIIT with basketball players should consider integrating it strategically within the broader training regimen. Ideally, HIIT sessions should be scheduled during the off-season or pre-season periods to avoid adding excessive load during the in-season when players are already engaged in frequent practices and games. In addition, when designing HIIT protocols, incorporating basketball-specific movements (e.g., lateral shuffles, and defensive slides) can make the training more applicable to game scenarios. This approach not only improves fitness but also reinforces movement patterns that players frequently use in games. However, there are some considerations to keep in mind. Moreover, while HIIT is beneficial for conditioning, it may not provide the skill-specific training needed for improvements in basketball



techniques such as shooting accuracy or passing precision. Coaches should balance HIIT with dedicated skill practice.

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### Key points

- HIIT significantly improves cardiovascular endurance, power, change of direction ability, and sprint performance in basketball players, with particularly strong effects on endurance measures like the Yo-Yo IR 1.
- The effects of HIIT on basketball-specific skills like shooting and passing are inconsistent, suggesting that HIIT should be supplemented with specific skill training.
- Coaches should carefully time HIIT interventions, particularly during the season, and tailor them to the player's age and skill level for optimal benefits.

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