

The Basics of Recovery in Basketball

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Introduction

Basketball is a high-intensity and intermittent team sport. Players rapidly change direction, sprint and jump throughout the match (Stojanovic et al., 2018; McInnes et al., 1995; Ben Abdelkrim et al., 2007). It has been reported that male and female basketball players cover a distance of approximately 5-6 km in a game and have a maximum heart rate above 85% (Stojanovic et al., 2018). In the game of basketball, both aerobic and anaerobic energy systems are engaged and glycolysis plays an important role in ATP production during high-intensity movements (McInnes et al., 1995). Therefore, carbohydrates are the main source of energy for basketball players (Williams and Rollo, 2015). In addition, a large amount of sweat loss has been observed during training and competitions. Protein and collagen supplementation is also important for muscle repair and recovery (Heaton et al., 2017).

Aim of The Study

The aim of this study was to investigate various recovery strategies for the improvement of sportive performance in basketball.

Energy Requirements in Basketball

The energy requirements of each sport vary depending on factors such as contact, duration, distance and intensity. This is related to the content of the training program rather than the type of training (Fox & Bowers, 1988). Aerobic capacity, which increases endurance in basketball, is an important physiological requirement for game performance (Bompa, 2011). Activities such as changes in direction, sudden runs, explosive power, jumps and sprints emphasize anaerobic energy consumption in the body (Ziv & Lidor, 2009).

Basketball is a sport that requires approximately 4/1 of aerobic energy and 4/3 of anaerobic energy. In practice, 80% of the anaerobic energy system (60% phosphogen and 20% lactic acid) is used for sustained high-intensity exercise. Basketball-specific short duration high-intensity movements are supported by the energy produced by lactic acid and the ATP-PC cycle in a short time. In this respect, basketball can be defined as a high-intensity team sport (Ziv and Lidor, 2009; Castagna and Abt, 2008). Therefore, both energy parameters (aerobic and anaerobic) should be considered when creating a training program for basketball and planning the recovery process after training and competitions. The need for high-level motoric characteristics in basketball makes anaerobic energy an important factor in energy capacity (Dündar, 1999; Sen, 2000).

In addition, the fluent integration of technical movements with coordination, explosive power and sprinter characteristics in the game provides high performance statistics depending on the playing time (Fox & Bowers, 1988; Sheppard, 2006).

Performance Elements in Basketball

Assessing and optimizing performance in basketball requires a detailed examination of a wide range of elements. These elements range from physical capacity to technical skills, from psychological resilience to tactical adaptations. Thus, basketball performance is a multi-layered construct that results from the effective combination of individual abilities and team strategies.

Basketball is a sport that requires high physical skills. The performance of players on the court is largely related to physiological parameters such as endurance, strength, speed, agility and flexibility. In particular, aerobic capacity (VO₂max) and anaerobic power are critical for players to perform at an optimal level throughout the match. Research shows that athletes with high VO₂max have lower fatigue levels and are able to perform at high levels for longer periods of time (Csataljay et al., 2009). At the same time, anaerobic power plays an important role in the sustainability of immediate high-intensity efforts such as short-distance sprints, explosive jumps, and fast reactions (Malarranha et al., 2013). At the time to peak torque, the contraction speed is at the forefront and its unit is the second. This refers to the time to reach peak torque. It is used in evaluating athletes that require explosive power and available condition (Vural, 2019).

Technical skills are one of the most decisive elements of basketball performance. Factors such as shooting accuracy, passing ability, dribbling and defensive skills affect players' individual and team roles. For example, field goal shooting percentage and three-point accuracy are critical indicators often used to measure a player's offensive performance (Oliver, 2011). However, passing ability and ball control increase the efficiency of offensive organizations by ensuring fluidity in team play. A good passer not only delivers the ball to the right place at the right time, but also optimizes the positioning and strategy of his teammates on the court (Yu et al., 2008).

In basketball, psychological endurance, as well as physical abilities, is a factor that greatly affects the performance of players. Basketball games are high-paced competitions that are often played under stress. Therefore, players' mental toughness is directly related to their ability to perform under pressure. Research shows that high levels of motivation, concentration, self-confidence, and the ability to cope with stress improve players' performance during games (Csataljay et al., 2009). Furthermore, social psychological factors such as leadership and team communication contribute to collective success by increasing team cohesion (Oliver, 2011).

Basketball is also a game of strategy and tactics. The team's game plan, offensive and defensive strategies ensure that the players' individual performances are used effectively. A well-planned strategy optimizes the team's overall performance while maximizing the players' abilities. For example, fast attacking strategies can break defensive resistance by controlling the tempo of the game (Malarranha et al., 2013). On the defensive side, a well-organized zone defense increases the team's probability of winning a match by reducing the offensive efficiency of the opposing team (Csataljay et al., 2009).

Performance in basketball is a multifaceted structure in which physical abilities, technical skills, psychological endurance and tactical elements work in harmony. These elements

not only affect the individual performance of the players, but also directly determine the overall success of the team. Therefore, athletes and coaches who want to improve basketball performance should give equal importance to each of these elements and develop training programs supported by scientifically based studies. A holistic approach to performance will improve not only individual development but also the effectiveness of team strategies.

Physical Recovery Process

The human body is designed to ensure the harmonious functioning of organs and systems by maintaining internal balance. This functioning is achieved through different levels of organ functioning. Especially in some sports, athletes are exposed to overloads by training at high intensity (Amann et al., 2015). Such intense overloads can lead to a decrease in athletes' performance. It can lead to problems such as inadequate recovery, increased fatigue, injury risks and loss of performance (Taylor et al., 2016).

Researchers and coaches aim to effectively clear metabolic wastes after sport and improve performance. The physical, physiological and mental recovery of athletes is a critical factor for maximum performance (Barnett, 2006). Recovery refers to the fastest way to eliminate fatigue after training or competition and return the athlete to their previous state. This process also contributes to the reorganization of energy metabolism (Bishop et al., 2008).

The energy expended during exercise varies depending on the intensity of the exercise and this affects the energy sources in the body. After training, the organism starts to repair the damage, depending on the energy expended. Recovery is a period in which this energy consumption continues. To understand metabolic recovery, some important metrics should be taken into account, including O₂-myoglobin oxygenation, return of energy sources to resting levels, removal of lactic acid, and closing the oxygen debt (Gnay et al., 2013; Murray et al., 2018).

The recovery process can vary depending on many factors and is therefore still an important area of research in sports science. Depending on the intensity of the training or competition, recovery time may vary. For example, athletes from different sports, such as basketball players and swimmers, may have different recovery techniques and processes. The physical and mental fatigue that occurs during training and competitions can lead to a decrease in performance and have detrimental effects on the body. The main purpose of recovery is to eliminate these negativities and ensure that the athlete is best prepared for the next training or competition.

Objectives of Physical Recovery

The main goal of the recovery process is to repair the damage caused during training or competition and to minimize and completely eliminate fatigue. In an effective recovery process, factors such as returning the organism's functions to their previous level, restoring the body's internal balance and compensating for the energy loss caused by high-intensity activities come to the fore (Bishop et al., 2008). In addition, recovery provides benefits such as accelerated blood flow, cleansing of waste materials in the blood and muscle, reduction of inflammation and edema. Other positive outcomes of effective recovery include reduced muscle stiffness and soreness, increased muscle flexibility, faster recovery of fitness and reduced effects of delayed onset muscle soreness

(Cochrane, 2004).

There are also various factors that affect the physical recovery process. The biological age, gender, experience, health status and ongoing injuries, if any, are among these factors. In addition, maximal oxygen consumption capacity and genetic characteristics, energy metabolism and the requirements of the sport also play an important role. Factors such as overload, eating habits and fluid-electrolyte balance can also affect the recovery process. Environmental factors, mental state and personal lifestyle are other factors that determine how recovery progresses. For example, sleep patterns, alcohol and smoking habits, stress and motivation can all have an impact on recovery. In addition, time changes after the journey can also negatively affect the recovery process (Jemni et al., 2003).

Classification of Physical Recovery

Physical recovery is broadly classified in three different ways according to duration: quick recovery, short-term physical recovery and long-term physical recovery. Rapid recovery refers to muscle regeneration between short-term and repetitive activities. For example, during walking, the recovery process between steps is related to the regeneration of ATP in the muscles and the removal of waste. This process improves athletes' performance by increasing their speed (Bishop et al., 2008). Short-term physical recovery is the type of recovery seen between sets. It aims to maintain the performance of the next movement by resting the muscles after an exercise movement and restoring energy metabolism. Studies have found that short recovery times (15-30 seconds) negatively affect performance (G, m, sdag et al., 2015). Long-term physical recovery takes place between training sessions or matches and aims for full recovery. Especially after aerobic exercises, 8 to 24 hours of rest is recommended, while more than 24 hours are required for full recovery (Bishop et al., 2008; Sporer and Wenger, 2003; Burke et al., 2006). In addition, many different methods are used to accelerate physical recovery in athletes (Alemdaroglu & Koz, 2011). These include low-tempo running, massage, cryotherapy, hydrotherapy, contrast applications, nutrition and fluid intake. In addition, acupuncture, ultrasound, pressure garments, electrical muscle stimulation, psychological therapy and lifestyle changes are also considered effective methods (Wilcock et al., 2006; Tessitore et al., 2007).

Traditional Recovery

Traditional recovery is a common method to reduce muscle fatigue and damage after high intensity exercise. The main purpose of this method, also known as active recovery, is to remove waste materials accumulated in the muscles and blood after exercise, re-synthesize high-energy phosphates, transport oxygen to the muscles and blood, regulate the body's internal balance and increase blood flow. This process makes the body's defense mechanisms more effective (Anderson et al., 2010; West, 2013). Active recovery increases metabolic rate and blood flow, allowing lactate to be removed faster through oxidation and gluconeogenesis, and thus fatigue decreases more quickly (Peifei et al., 2021). However, the duration and intensity of recovery should be well-tuned; too long or intense a recovery period may cause the athlete to become overtired or accumulate waste materials. Optimal recovery can be achieved with activities such as low-paced running, jogging, stretching, cycling, and swimming lasting 10-30 minutes at 30% to 50% of maximal heart rate (Warren et al., 2014). Research has shown that traditional recovery accelerates the electromyographic activity of muscles and reduces muscle

spasms (Cheung et al., 2003). In addition, this method can help increase oxygen levels, hemoglobin and myoglobin levels in muscles (Koizumi et al., 2011).

Massage

Massage is an important recovery method used to alleviate exercise-related fatigue and stress. Massage, which has been used throughout history to improve human health, treat diseases and strengthen the body, is also frequently preferred in the physical recovery of athletes (Mori et al., 2004). First defined in 1863 with various techniques, massage is a set of systematic movements that improve the body physically, functionally and anatomically by acting on muscle tissues (Noble et al., 2007). This method is applied to increase muscle tone, stimulate circulation and balance the nervous-muscular systems (Benjamin et al., 2005).

Massage produces various reactions on the organism through mechanical stimuli. These reactions occur at different levels depending on the technique applied and are locally effective on the skin, subcutaneous tissues and muscles and can reach the internal organs through reflexes. The physiological, mechanical and psychological effects of massage are seen in the locomotor system, cardiovascular system and other body structures. The benefits of massage include accelerating cell regeneration, removing toxins and waste products accumulated in the muscles, increasing blood circulation, reducing muscle fatigue and pain, preventing muscle damage and accelerating the recovery process. It also reduces pain and lowers the level of stress hormones by increasing endorphin release (Powell et al., 2015; Kara & İner, 2019). Especially sports massage is widely practiced to accelerate recovery during and after physical activity and exercises (Budak, 2018). One of the reasons for the use of massage in sport recovery is the assumption that it helps to rapidly remove lactate accumulation from the body. With lactate accumulation, the body pH decreases, which suppresses the activity of the enzyme phosphofructokinase and slows down glycolysis. Energy production is reduced and this limits the effective contractile capacity of muscles. The lactate accumulated in the muscles and bloodstream causes fatigue (Bangsbo et al., 1994; Sahlin, 1992). Many studies have been conducted to investigate the effect of massage on this fatigue-inducing metabolite; however, these studies revealed that massage did not have a significant effect on the elimination of lactic acid from the body. However, there are also studies indicating that massage has positive results on performance measures such as fatigue index and total work done (K[^]seoglu and Kin. 2000; Ogai et al., 2008; Ernst 1998; Appell et al., 1992). In a recent study, massage was found to increase heart rate variability, increase parasympathetic activity and decrease sympathetic activity in college basketball players (Kaesaman, 2019). The massage was performed at halftime of a simulated basketball game, with players receiving a 10-minute traditional Thai massage or simply resting. These indicators may suggest a reduction in fatigue in basketball players (Edwards et al., 2008); however, it is not clear whether these results are beneficial or detrimental to players at half-time and how they relate to on-court performance or post-match recovery. Although seen as an innovative approach, it may be difficult to implement massage at half-time in practice. At this stage, players may need to focus more on energy intake, hydration and the coach's strategic plans for the second half. Future research should elaborate on these results to better understand the effects of such massage techniques on post-match recovery (Davis et al., 2022).

Hydrotherapy

Hydrotherapy is a recovery method that has recently increased in popularity and is frequently used especially among athletes. In this method, which is applied to accelerate post-exercise regeneration, factors such as the duration, frequency, depth and temperature of the water affect the recovery process. Generally, a water immersion therapy at normal temperature lasts between 10 and 30 minutes (Wilcock et al., 2006). Hydrotherapy creates various physiological changes by entering the water to refresh the body after intense physical activities. These changes start with the hydrostatic pressure of the water and continue with positive effects such as fluid exchange in the body, increased circulation rate, improvement in cardiovascular functions, and reduction of edema accumulated in muscle groups (Vaile et al., 2008). It has also been stated that it has benefits such as relaxing the person mentally and increasing alertness (Jeffreys, 2005). Hydrotherapy is recognized as an effective method that supports physical and mental recovery.

Cryotherapy

Cryotherapy involves the application of cold or immersion in cold water and is frequently used both to accelerate recovery after intense exercise and to treat trauma and injury. This application causes changes in skin, muscle and joint temperature, while heart rate and cardiac output decrease, blood pressure and peripheral resistance increase (Cheung et al., 2003; Wilcock et al., 2006). The main effect of cryotherapy is to reduce pain and inflammation after exercise by lowering local tissue temperature and blood flow (Barnett, 2006). The pain relief effect occurs by decreasing the nerve conduction velocity and altering the pain perception of the central nervous system. However, this may also affect muscle contraction rate and strength capacity, leading to a short-term decrease in performance. Therefore, the most effective application time of cryotherapy is recommended to be performed immediately after exercise for approximately 15-20 minutes (Rutkove, 2001).

Cryotherapy applications in the literature are as follows:

1. A 14-minute bath at 15°C for the whole body except the head and neck (Vaile and Gill, 2007).
2. One-minute baths at 10°C, followed by 15°C and 20°C for the whole body except the head and neck, and 2 minutes of rest out of the water after each session (Vaile et al., 2008),
3. Applying water at 15°C to the legs for 15 minutes (Lane and Wenger, 2004). Applying water at 8°C to the legs for 10 minutes (Burke, 2000).

Although it is a common method for post-exercise recovery, scientific evidence supporting the efficacy of cryotherapy is limited. Some studies suggest that cryotherapy has little effect on muscle damage after exercise (Howatson et al., 2009). However, in a study conducted by Demirhan (2013) on elite wrestlers, it was found that eight minutes of cold application significantly reduced myoglobin and Creatine Kinase levels and accelerated recovery. Abaidia et al. (2017), in a study conducted in trained individuals, reported that cold water immersion positively affected active jump performance at 72 hours after exercise, while subjects felt less pain and perceived recovery levels were higher between 24-48 hours. There are studies examining the effect of cryotherapy on post-match recovery in basketball players. (2018) investigated the effects of cryotherapy on 24 French national team players participating in the European Championship. In the

study, the thermal sensations (cold perception) of international level male and female basketball players to cold exposure at -130°C for 3 minutes were evaluated. Cryotherapy was applied to the whole body, except the head and neck, every afternoon for 2 weeks. The results showed that the 3-minute cryotherapy sessions were well tolerated by both male and female elite basketball players and could be used during intense periods of matches or training. However, significant individual differences in thermal sensations between players were reported. These differences were largely attributed to differences in the body mass index (BMI) of the players. In particular, it was emphasized that female basketball players with lower BMI are more sensitive to cold and this may affect compliance with cryotherapy. Other studies with similar temperatures (-110°C) and exposure times (3 minutes) show a reduction in muscle soreness (Ferreira-Junior et al., 2015) and accelerated recovery in eccentric muscle performance.

Contrast water application

Contrast water application is a widely used and increasingly popular method to accelerate recovery, especially after sports. In this application, alternating hot and cold water is used to regulate blood flow in muscle cells. The temperature of cold water should generally be between $10-15^{\circ}\text{C}$ and hot water between $36-42^{\circ}\text{C}$. The application time is 20-30 minutes on average, starting with hot water and ending with cold water. In the first stage, hot water is used for five minutes, followed by cold water for one minute and this cycle is repeated until the end of the duration. Contrast water therapy is applied especially after intense physical activity in order to remove waste substances from the body, reduce edema and restore internal balance. It also alleviates inflammation and edema by reducing spasms and stiffness in muscle groups (Bieuzen et al., 2013). In a study conducted by Hamlin in 2007 on rugby players, it was reported that this method did not have a direct effect on repetitive sprint performance, but it was beneficial on delayed muscle soreness. In another study conducted by Forghani et al. in 2015 with male university students, contrast water application was found to significantly reduce blood lactic acid levels after intense exercise.

Nutrition and Fluid Intake

To replenish glycogen stores in the muscles after high-intensity exercise or racing, it is important to consume foods with a high glycemic index and high carbohydrate content. Such foods, taken intermittently in the first five hours after exercise, are effective in rapidly replenishing glycogen stores in the muscles.

Carbohydrate and protein intake promotes greater glucose entry into muscle tissues by increasing insulin and glycogen secretion (Jentjen and Jeukendrup, 2003). High-intensity exercise increases protein synthesis in muscles, but also accelerates its breakdown. Therefore, without post-load protein intake, there is a risk of a negative protein balance. Reducing protein breakdown and maintaining a positive protein balance after vigorous exercise is necessary to rapidly eliminate muscle damage (Beelen et al., 2010).

Oxidative stress occurs when the body's capacity to defend itself against free radicals is inadequate. Reactive oxygen species are the main source of oxidative stress and play an important role in the onset and progression of damage to muscle fibers after exercise (Bloomer et al., 2004). Various antioxidants such as vitamins C and E, carotenoids and flavonoids have been proposed to protect cells against free radicals (Packer, 1991).

Oxidative stress may be associated with the aging process, cell damage, muscle fatigue and overtraining, especially in a strenuous sport such as basketball (Finaud et al., 2006). Given that more aerobic metabolism is utilized in basketball than expected, the effects of oxidative stress may be more pronounced at maximal levels of exercise. For example, VO₂ values for female basketball players were 33.4-40.0 mL/kg/min and 36.9-42.6 mL/kg/min for men (Narazaki and Berg, 2009). In this context, consumption of vitamins C and E may strengthen the antioxidant defense system by reducing reactive oxygen species in athletes performing high-intensity exercise (Naziroglu et al., 2010). Looking at the dietary habits of players, it has been shown that multivitamins are the most commonly used supplements (50.9%), followed by sports drinks (21.8%) (Schroder et al., 2002).

In case of decreased fluid intake, it has been observed that post-exercise drinks containing simple carbohydrates contribute positively to the recovery process in muscle function. In particular, milk, as an easily accessible post-match option, is beneficial in the recovery process as it is a carbohydrate and protein-rich food. It is thought that milk and similar drinks containing 20 grams of protein and approximately 9 grams of amino acid intake is sufficient for the organism after exercise. In a study, it was reported that chocolate milk taken after training increased protein synthesis in the cell and decreased the level of pain threshold, and also increased the amount of creatine kinase (Cockburn et al., 2008; Nedelec et al., 2013).

Compression garments

Nowadays, compression garments, which have gained popularity especially among team athletes, are frequently used to accelerate recovery and heal trauma to muscle tissues. This method, which is thought to be effective on parameters such as muscle damage, swelling and pain threshold after maximal loads, aims to reduce muscle damage and lower lactate dehydrogenase levels by providing pressure and relaxation in the applied areas (De Glanville and Hamlin, 2011).

The effectiveness of compression garments depends on accurately adjusting and maintaining the applied pressure (Cockburn et al., 2008; Davies et al., 2009). In a study conducted on this subject, Gill et al. (2006) reported that the use of a full-leg compression garment for 12 hours following the end of a race had positive effects on creatine kinase clearance and physical recovery in elite rugby players. These findings suggest that compression garments may help to improve athletes' recovery processes. The most important point in winning or losing is to work and make an effort. Afterwards, success often comes naturally. However, it should also be known that working and making efforts will not always produce successful results. When the result fails despite the team's best efforts; It should be accepted and accepted that the entire Team in front of you deserves to win more than you. In other words, it should be accepted that the other team made fewer mistakes and the luck factor was on the side of this team (Erdoğan, 2022; Erdoğan, 2023).

To date, only one study has investigated the use of compression garments (CGs) in the measurement of post-exercise muscle damage in a basketball context. Montgomery et al. (Montgomery et al., 2008b) showed that wearing a CG for 18 hours after a basketball game did not result in a significant benefit in measures of muscle damage, including blood biomarkers such as creatine kinase, fatty acid binding protein, myoglobin, interleukin (IL)-6 and IL-10, and thigh circumference (Brown et al., 2020; Zinner et

al., 2017; Davies et al., 2009). These results contradict research indicating that post-exercise CG use leads to a reduction in markers of muscle damage. Furthermore, several meta-analyses show that CG use is effective in reducing creatine kinase levels and muscle swelling after exercise (Marquès-Jiménez et al., 2016; Hill et al., 2014). A possible reason for these lackluster results reported in Montgomery (2008b) and other compression studies is that the exercise protocols used were not intense enough to cause enough muscle damage. Supporting this, a meta-analysis suggests that the use of QA is more beneficial after resistance training than after endurance or running activities. Studies by Montgomery (2008) and Atkins (2020) showed that wearing a lower body KG after basketball exercises did not improve performance recovery. However, previous research has shown that the use of CG after exercise improves performance recovery (Brown et al., 2020; Hettchen et al., 2019; Jakeman et al., 2010). A possible reason for the lack of any benefit in performance recovery in these basketball studies may be that the KG does not apply sufficient pressure. For example, in Atkins' study, 7-10 mmHg pressure was applied to the lower body, but >14 mmHg pressure is effective for exercise recovery, while >20 mmHg pressure is recommended to increase blood flow. It has also been reported that venous and muscular blood flow in the lower limbs of basketball players increased with various types of CG (tights, socks, shorts) (O'Riordan et al., 2021). These findings suggest that CG is an effective strategy to increase blood flow in basketball players and that this is the underlying mechanism behind its benefits in recovery (MacRae et al., 2011; Brown et al., 2017).

Sleep

Sleep stands out as one of the most effective recovery strategies in athletes (Walsh et al., 2021). Sleep plays a critical role in performance, mental functioning, energy metabolism, muscle repair, mood and disease prevention (Halsen, 2019). In high-paced team sports with intense match schedules, such as basketball, maintaining and improving sleep is of great importance as recovery time may be limited. Although studies on sleep in professional basketball are limited, research on lower-level athletes and other team sports can shed light on sleep problems in basketball players.

A recent study reported that elite athletes need 8.3 ± 0.9 hours of sleep to feel rested (Sargent et al., 2021). However, 71% of athletes do not meet this requirement and sleep an average of 6.7 ± 0.8 hours. This leads to an average sleep deficit of 96 ± 60 minutes. When different sports branches were compared, it was observed that basketball players woke up the latest ($07:54 \pm 00:24$ hours) and had the longest sleep duration (7.5 ± 0.4 hours).

One of the studies supporting the positive effects of sleep on performance in basketball is the study conducted by Mah and colleagues (2011). As a result of increasing sleep duration in male university basketball players for 5-7 weeks, it was observed that sprint times, shot accuracy rate and reaction times improved. As a result of increasing the time athletes spent in bed to 10 hours, their sleep time increased by 110.9 ± 79.7 minutes.

Many elite athletes report experiencing poor sleep, especially after night matches. This situation becomes even more difficult during busy match schedules. In one study, it was found that the total sleep time of basketball players during double match weeks was 11% shorter than during normal match weeks (Lastella et al., 2020). In addition, it has been observed that adrenaline and noradrenaline levels are higher in elite athletes before and after night matches than on rest days. This suggests that athletes with high arousal

tendencies are more prone to sleep problems after night matches (Staunton et al., 2017; Juliff et al., 2018).

Training and competition loads can also affect sleep quality. Studies have shown that on training days with moderate to high loads, athletes have later bedtimes and reduced total sleep time. Similar findings have been observed among other elite athletes; high running speeds and training loads negatively affect sleep quality (Fox et al., 2020).

Sleep patterns may also be associated with injury and illness. In a study of netball athletes, low sleep duration increased the risk of injury, while poor sleep quality or excessive sleep increased the risk of illness. These findings suggest a possible link between sleep and health problems (Lalor et al., 2020).

It is recommended that basketball players benefit from sleep monitoring, feedback and education to improve their sleep quality. Reducing screen time, avoiding inappropriate caffeine intake, and raising awareness about sleep habits can improve athletes' sleep quality (Bei et al., 2017). Furthermore, research in elite athletes emphasizes that comfortable travel with quality sleep can have protective effects on performance (Horgan et al., 2021).

Hyperbaric Oxygen Therapy

Oxygen debt of the organism, especially after anaerobic exercises, can have various negative physiological consequences. In this context, frequent ventilation of athletes' spaces, entering environments with higher oxygen levels if possible, and performing low-paced activities can improve recovery processes. Hyperbaric oxygen therapy promotes the uptake of more oxygen into the organism, where it is dissolved in the plasma and transported to the damaged tissue. This process can also lead to indirect increases in blood flow rate and muscle strength.

In various studies, hyperbaric oxygen therapy has been reported to have positive effects on delayed muscle soreness, pain threshold, perceived tenderness, edema, isometric contraction, muscle cross-sectional area and serum creatine kinase levels (Harrison et al., 2001). These findings suggest that hyperbaric oxygen therapy can be used as a potential therapeutic method in the recovery process of athletes.

Electric Stimulation

Methods such as galvanic, interference and transcutaneous electrical nerve stimulation (TENS) are widely used in rehabilitation processes for pain in the skeletal-muscular system after strenuous work. The TENS device has increased in popularity in recent years and can be applied by patients themselves at home. The electrodes of the device are recommended to be placed on the painful area and used for approximately 30 minutes (Babault et al., 2011). There are many types of TENS method; the most commonly used are superficial electrodes placed on the skin and low-frequency methods operating in the frequency range of 10-100 Hz. Electrical stimulation, which stands out as a popular passive recovery method among both team athletes and individual athletes, provides effective benefits, especially in the removal of waste substances from the body (Tessitore et al., 2007). This method can help improve the performance of athletes by contributing to the muscle recovery process.

Effects of recovery on performance in basketball

Various studies on the effects of recovery on performance in basketball show that recovery processes have significant effects on muscle damage, performance sustainability and general well-being of athletes (Calleja-González, et al., 2016). In particular, different recovery protocols applied after training play a critical role in preventing muscle damage and sustaining performance (Mihajlovic, et al., 2023).

One study examined cold water immersion, hot water immersion, active recovery (e.g. light jogging) and passive rest and found that cold water immersion in particular was more effective than other methods in reducing muscle damage and accelerating recovery. Among these protocols, recovery was found to have different effects on delayed muscle soreness, body temperature and creatine kinase levels. Cold water immersion was observed to accelerate the recovery process and reduce muscle soreness, especially after 48 and 72 hours (Çelebi, 2018). The effect of recovery on basketball performance becomes more evident in post-match and intensive training processes. Effective recovery methods help athletes maintain muscle strength and endurance, while helping to prevent injuries and prevent performance decline (Çelebi, 2018). Uygur et al (2010) examined the effect of fatigue on free throw kinematics and reported that fatigue did not affect free throw kinematics and was not an important factor.

Gülü et al (2021) examined the relationship between running distance and technical parameters in basketball and reported that as the players stayed in the game longer during the competition, their shooting percentages decreased with the increase in fatigue. Kılıç (2010) examined the effects of basketball tournament on muscle damage and recovery time and reported that athletes who had 10 minutes of active rest returned to normal faster than athletes who had passive rest.

In the study investigating the physiological correlates of Yo-Yo intermittent recovery test level 1 (Yo-Yo IR1) in basketball players, maximum oxygen uptake (VO_{2max}), ventilatory threshold (VT) and running economy (RE) were tested in twenty-two male basketball players. There was no difference between CMJ and 15 mSR performances in pre- and post-game tests, while LD performance decreased significantly. Yo-Yo IR1 results showed significant relationships with VO_{2max} and speed. These findings suggest that the Yo-Yo IR1 is a valid test for aerobic fitness and endurance in basketball (Castagna et al., 2008a).

In a study investigating the effect of recovery methods on repeated sprinting ability in young basketball players, sixteen players tested passive and active recovery methods during a 30-meter 10-repetition sprint. The results showed that the fatigue index was higher during active recovery than passive recovery. Furthermore, no significant relationship was found between VO_{2max} and fatigue index and total sprint time. These findings suggest that passive recovery provides better performance and reduces fatigue in repeated sprints (Castagna et al., 2008b). In a basketball tournament, the effects of different recovery methods were examined in 29 players. Players were divided into carbohydrate + stretching, cryotherapy (11°C) or compression garments groups. Slight decreases in performance due to fatigue were observed during the tournament. Sprint performance decreased by 0.7% and agility by 2%. Vertical jump decreased significantly after the first day. Cryotherapy was the best method to maintain 20 m acceleration performance. Cryotherapy and compression garments had similar effects on line drill performance. Overall, cryotherapy was more effective in recovery (Montgomery et al., 2008a).

Conclusion

Recovery is considered one of the most important parts of the training program in basketball as in other sports. Carbohydrates and fluids play an important role in maximizing the efficiency of recovery after training and competition. Having high muscle glycogen concentrations and adequate fluid intake can be achieved by high carbohydrate consumption plus leucine (amino acid) and adequate fluid consumption. Cold water immersion can be an effective strategy to reduce delayed onset muscle soreness 24 hours after a match. A combination of massage and stretching has shown positive effects on recovery immediately after a match. Several nutritional factors have been suggested that may influence recovery: for example, a high glycemic index diet and a balanced diet before bedtime to improve sleep may be beneficial. Strategies such as skin warming, hydrotherapy and proper sleep hygiene practices are other tools used to promote sleep. Ensuring that athletes get adequate quantity and quality of sleep can be important for optimal athletic performance. Applying hydrotherapy in different combinations in a personalized way can be effective. It is important to take a tailored approach to recovery strategies, taking into account factors such as the athlete's playing time, hydration and nutritional needs, muscle soreness and fatigue level. Overall, a strategic and balanced approach that encompasses both nutrition and recovery methods should be carefully considered and implemented to support the basketball player's recovery throughout the season. Finally, more research is needed to identify resources that best provide individualized recovery strategies.

References

- Abaidia, A. E., Lamblin, J., Delecroix, B., Leduc, C., McCall, A., & Dupont, G. (2017). Recovery from exercise induced muscle damage: Cold water immersion versus whole-body cryotherapy. *International Journal of Sports Physiology and Performance*, 12(3), 402-409. <https://doi.org/10.1123/ijsp.2016-0176>
- Alemdaroğlu, B. U., & Koz, M. (2011). Recovery after exercise: Types and methods of recovery.
- Amann, M., Sidhu, S. K., Weavil, J. C., Mangum, T. S., & Venturelli, M. (2015). Autonomic responses to exercise: Group III/IV muscle afferents and fatigue. *Autonomic Neuroscience*, 188, 19-23. <https://doi.org/10.1016/j.autneu.2014.10.018>
- Anderson, H., Bohn, S. K., & Raastad, T. (2010). Differences in the inflammatory plasma cytokine response following two elite female soccer games separated by a 72-h recovery. *Scandinavian Journal of Medicine & Science in Sports*, 20(5), 740-747. <https://doi.org/10.1111/j.1600-0838.2009.00974.x>
- Appell, H., Soares, J., & Durate, J. (1992). Exercise, muscle damage and fatigue. *Sports Medicine*, 13(2), 108-115. <https://doi.org/10.2165/00007256-199213020-00005>
- Atkins, R., Lam, W. K., Scanlan, A. T., Beaven, C. M., & Driller, M. (2020). Lower-body compression garments worn following exercise improves perceived recovery but not subsequent performance in basketball athletes. *Journal of Sports Sciences*, 38(9), 961-969. <https://doi.org/10.1080/02640414.2019.1663374>
- Babault, N., Cometti, C., & Maffiuletti, N. A. (2011). Does electrical stimulation enhance post-exercise performance recovery? *European Journal of Applied Physiology*, 111(10), 2501-2507. <https://doi.org/10.1007/s00421-011-1888-4>
- Bangsbo, J., Graham, T., Johansen, L., & Saltin, B. (1994). Muscle lactate metabolism in recovery from intense exhaustive exercise: Impact of light exercise. *Journal of Applied Physiology*, 77(4), 1890-1895. <https://doi.org/10.1152/jappl.1994.77.4.1890>

- Barnett, A. (2006). Using recovery modalities between training sessions in elite athletes: Does it help? *Sports Medicine*, 36(9), 781-796. <https://doi.org/10.2165/00007256-200636090-00005>
- Beelen, M., Burke, L. M., & Gibala, M. J. (2010). Nutritional strategies to promote postexercise recovery. *International Journal of Sport Nutrition and Exercise Metabolism*, 20(6), 515-532. <https://doi.org/10.1123/ijsnem.20.6.515>
- Bei, B., Manber, R., Allen, N. B., Trinder, J., & Wiley, J. F. (2017). Too long, too short, or too variable? Sleep intraindividual variability and its associations with perceived sleep quality and mood in adolescents during naturalistically unconstrained sleep. *Sleep*, 40(2). <https://doi.org/10.1093/sleep/zsw067>
- Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine*, 41(2), 69-75. <https://doi.org/10.1136/bjsm.2006.031319>
- Benjamin, P. J., & Lamp, S. P. (2005). Understanding sports massage. *Human Kinetics*.
- Bieuzen, F., Bleakley, C. M., & Costello, J. T. (2013). Contrast water therapy and exercise induced muscle damage: A systematic review and meta-analysis. *Plos One*, 8(4), 56-62. <https://doi.org/10.1371/journal.pone.0062356>
- Bishop, P. A., Jones, E., & Woods, A. K. (2008). Recovery from training: A brief review. *Journal of Strength and Conditioning Research*, 22(3), 1015-1024. <https://doi.org/10.1519/JSC.0b013e31816eb518>
- Bloomer, R. J., Goldfarb, A. H., McKenzie, M. J., et al. (2004). Effects of antioxidant therapy in women exposed to eccentric exercise. *International Journal of Sport Nutrition and Exercise Metabolism*, 14(4), 377-388. <https://doi.org/10.1123/ijsnem.14.4.377>
- Bompa, T. O. (2011). *Training theory and method* (4th edition). Bagirgan Publishing House.
- Bouzigon, R., Ravier, G., Dugue, B., & Grappe, F. (2018). Thermal sensations during a partial-body cryostimulation exposure in elite basketball players. *Journal of Human Kinetics*, 62(1), 55-63. <https://doi.org/10.1515/hukin-2017-0166>
- Brooks, G. A., Gaesser, G. A., & White, T. P. (1994). Muscle lactate metabolism in recovery from intense exhaustive exercise: Impact of light exercise. *Journal of Applied Physiology*, 77(4), 1890-1895. <https://doi.org/10.1152/jappl.1994.77.4.1890>
- Brown, F., Gissane, C., Howatson, G., van Someren, K., Pedlar, C., & Hill, J. (2017). Compression garments and recovery from exercise: A meta-analysis. *Sports Medicine*, 47(11), 2245-2267. <https://doi.org/10.1007/s40279-017-0737-7>
- Brown, F., Jeffries, O., Gissane, C., Howatson, G., van Someren, K., & Pedlar, C. (2020). Custom-fitted compression garments enhance recovery from muscle damage in Rugby players. *Journal of Strength and Conditioning Research*, 34(2), 536-543. <https://doi.org/10.1519/JSC.0000000000003083>
- Brown, F., Jeffries, O., Gissane, C., Howatson, G., van Someren, K., Pedlar, C., et al. (2020). Custom-fitted compression garments enhance recovery from muscle damage in rugby players. *Journal of Strength and Conditioning Research*. <https://doi.org/10.1519/JSC.0000000000003083>
- Budak, H. (2018). The effect of selected massage manipulations on recovery after anaerobic running. (Published Master's Thesis), Selçuk University, Institute of Health Sciences, Konya.
- Burke, D. G. (2000). The effect of hot or cold water immersion on isometric strength training. *Journal of Strength and Conditioning Research*, 14(1), 21-25. <https://doi.org/10.1519/JSC.0000000000003083>

- doi.org/10.1519/00124278-200002000-00004
- Burke, L. M., Loucks, A. B., & Broad, N. (2006). Energy and carbohydrate for training and recovery. *Journal of Sports Sciences*, 24(7), 675-685. <https://doi.org/10.1080/02640410500578347>
- Calleja-González, J., Terrados, N., Mielgo-Ayuso, J., Delextrat, A., Jukic, I., Vaquera, A., ... & Ostojic, S. M. (2016). Evidence-based post-exercise recovery strategies in basketball. *The Physician and Sportsmedicine*, 44(1), 74-78. <https://doi.org/10.1080/00913847.2016.1102033>
- Castagna, C., Abt, G., Manzi, V., Annino, G., Padua, E., & D'Ottavio, S. (2008). Effect of recovery mode on repeated sprint ability in young basketball players. *The Journal of Strength & Conditioning Research*, 22(3), 923-929. <https://doi.org/10.1519/JSC.0b013e31816a5e16>
- Castagna, C., Impellizzeri, F. M., Rampinini, E., D'Ottavio, S., & Manzi, V. (2008). The Yo-Yo intermittent recovery test in basketball players. *Journal of Science and Medicine in Sport*, 11(2), 202-208. <https://doi.org/10.1016/j.jsams.2007.05.002>
- Cheung, K., Hume, P. A., & Maxwell, L. (2003). Delayed onset muscle soreness. *Sports Medicine*, 33(2), 145-164. <https://doi.org/10.2165/00007256-200333020-00005>
- Cochrane, D. (2004). Alternating hot and cold water immersion for athlete recovery: A review. *Physical Therapy in Sport*, 5(1), 26-32. <https://doi.org/10.1016/j.ptsp.2003.10.002>
- Cockburn, E., Hayes, P. R., & French, D. N. (2008). Acute milk-based protein-CHO supplementation attenuates exercise-induced muscle damage. *Applied Physiology, Nutrition, and Metabolism*, 33(4), 775-783. <https://doi.org/10.1139/H08-051>
- Csataljay, G., O'Donoghue, P., Hughes, M., & Dancs, H. (2009). Performance indicators that distinguish winning and losing teams in basketball. *International Journal of Performance Analysis in Sport*, 9(1), 60-66. <https://doi.org/10.1080/14763140908522875>
- Çelebi, B. (2018). The effect of different recovery protocols on the prevention of muscle damage after training in athletes. (Unpublished master's thesis).
- Davies, V., Thompson, K. G., & Cooper, S. M. (2009). The effects of compression garments on recovery. *Journal of Strength and Conditioning Research*, 23(6), 1786-1794. <https://doi.org/10.1519/JSC.0b013e3181b335e0>
- Davis, J. K., Oikawa, S. Y., Halson, S., Stephens, J., O'Riordan, S., Luhrs, K., ... & Baker, L. B. (2022). In-season nutrition strategies and recovery modalities to enhance recovery for basketball players: A narrative review. *Sports Medicine*, 1-23. <https://doi.org/10.1007/s40279-022-00556-2>
- De Glanville, K. M., & Hamlin, M. J. (2012). Positive effect of lower body compression garments on subsequent 40-km cycling time trial performance. *Journal of Strength and Conditioning Research*, 26(2), 480-486. <https://doi.org/10.1519/JSC.0b013e318225ff92>
- Demirhan, B. (2013). The effect of ice massage on some biochemical parameters related to recovery in wrestlers. (Published Doctoral Dissertation), Gazi University, Institute of Health Sciences, Ankara.
- Dündar, U. (1999). *Conditioning in basketball*. Bagirgan Publishing House.
- Edwards, T., Spiteri, T., Piggott, B., Bonhotal, J., Haff, G. G., & Joyce, C. (2018). Monitoring and managing fatigue in basketball. *Sports*, 6(1), 1. <https://doi.org/10.3390/sports6010001>
- Erdoğan, B. (2023). *Uptempo Basketball*. Akademisyen Publishing. (ISBN:978-625-

- 399-483-9).
- Erdoğan, B. (2022). *Basketball Offense*. Akademisyen Publishing. (ISBN:978-625-8299-15-1)
- Ernst, E. (1998). Does post-exercise massage treatment reduce delayed onset muscle soreness? A systematic review. *British Journal of Sports Medicine*, 32(3), 212-213. <https://doi.org/10.1136/bjism.32.3.212>
- Ferreira-Junior, J. B., Bottaro, M., Vieira, A., Siqueira, A. F., Vieira, C. A., & Durigan, J. L. (2015). One session of partial-body cryotherapy (-110°C) improves muscle damage recovery. *Scandinavian Journal of Medicine & Science in Sports*, 25(5), e524-e530. <https://doi.org/10.1111/sms.12373>
- Ferreira-Junior, J. B., Bottaro, M., Vieira, C. A., Soares, S. R., Vieira, A., Cleto, V. A., et al. (2014). Effects of partial-body cryotherapy (-110°C) on muscle recovery between high-intensity exercise bouts. *International Journal of Sports Medicine*, 35(14), 1155-1160. <https://doi.org/10.1055/s-0034-1375694>
- Finaud, J., Lac, G., & Filaire, E. (2006). Oxidative stress: Relationship with exercise and training. *Sports Medicine*, 36(4), 327-358. <https://doi.org/10.2165/00007256-200636040-00004>
- Forghani, M., Aliabadi, S. R., & Firozmandi, A. (2015). The effect of contrast temperature water therapy on blood lactic acid clearance of male students of Mazandaran University of Science and Technology after exhausting activity. *International Journal of Applied Exercise Physiology*, 4(2), 51-58. <https://doi.org/10.22077/ijepa.2017.244>
- Fox, E. L., Bowers, R. W., & Foss, M. L. (1988). *The physiological basis of physical education and athletics* (4th ed.). Saunders College Publishing.
- Fox, J. L., Scanlan, A. T., Stanton, R., O'Grady, C. J., & Sargent, C. (2020). Losing sleep over it: Sleep in basketball players affected by game but not training workloads. *International Journal of Sports Physiology and Performance*, 15(7), 1004-1010. <https://doi.org/10.1123/ijsp.2019-0249>
- G, I., M., & Durmus, T. (2021). The relationship between running distance and technical parameters in basketball. *Spormetre Journal of Physical Education and Sports Sciences*, 19(4), 184-191. https://doi.org/10.1501/Spormetre_0000000308
- Gill, N. D., Beaven, C. M., & Cook, C. (2006). Effectiveness of postmatch recovery strategies in rugby players. *British Journal of Sports Medicine*, 40(3), 260-263. <https://doi.org/10.1136/bjism.2005.022483>
- Gümüşdağ, H., Egesoy, H., & Cerit, E. (2015). Recovery strategies in sports. *Hitit University Journal of Institute of Social Sciences*, 8(1), 53-69.
- Günay, M., Tamer, K., & Cicioglu, I. (2013). *Endocrine system, sports physiology and performance measurement*. Gazi Bookstore.
- Halsen, S. L. (2019). Sleep monitoring in athletes: Motivation, methods, miscalculations and why it matters. *Sports Medicine*, 49(10), 1487-1497. <https://doi.org/10.1007/s40279-019-01100-3>
- Hamlin, M. J. (2007). The effect of contrast temperature water therapy on repeated sprint performance. *Journal of Science and Medicine in Sport*, 10(6), 398-402. <https://doi.org/10.1016/j.jsams.2006.10.007>
- Heaton, L. E., Davis, J. K., Rawson, E. S., Nuccio, R. P., Witard, O. C., Stein, K. W., ... & Baker, L. B. (2017). Selected in-season nutritional strategies to enhance recovery for team sport athletes: A practical overview. *Sports Medicine*, 47(11), 2201-2218. <https://doi.org/10.1007/s40279-017-0759-2>
- Hettchen, M., Glöckler, K., von Stengel, S., Piechele, A., Lützerich, H., Kohl, M., et

- al. (2019). Effects of compression tights on recovery parameters after exercise-induced muscle damage: A randomized controlled crossover study. Evidence-Based Complementary and Alternative Medicine, 2019, 5698460. <https://doi.org/10.1155/2019/5698460>
- Hill, J., Howatson, G., van Someren, K., Leeder, J., & Pedlar, C. (2014). Compression garments and recovery from exercise-induced muscle damage: A meta-analysis. British Journal of Sports Medicine, 48(18), 1340-1346. <https://doi.org/10.1136/bjsports-2013-092456>
- Horgan, B. G., Drew, M. K., Halson, S. L., Piromalli, L. E., Drinkwater, E. J., Chapman, D. W., et al. Impaired recovery is associated with increased injury and illness: A retrospective study of 536 female netball athletes. Scandinavian Journal of Medicine & Science in Sports, 31(3), 691-701. <https://doi.org/10.1111/sms.13915>
- Howatson, G., Goodall, S., & Van, K. A. (2009). The influence of cold water immersions on adaptation following a single bout of damaging exercise. European Journal of Applied Physiology, 105(4), 615-621. <https://doi.org/10.1007/s00421-008-0941-1>
- Jakeman, J. R., Byrne, C., & Eston, R. G. (2010). Lower limb compression garment improves recovery from exercise-induced muscle damage in young, active females. European Journal of Applied Physiology, 109(6), 1137-1144. <https://doi.org/10.1007/s00421-010-1432-7>
- Jeffreys, I. A. (2005). Multidimensional approach to enhancing recovery. Strength and Conditioning Journal, 27(5), 78-85. <https://doi.org/10.1519/00126548-200510000-00014>
- Jemni, M., Sands, W. A., Friemel, F., & Delamarche, P. (2003). Effect of active and passive recovery on blood lactate and performance during simulated competition in high level gymnasts. Canadian Journal of Applied Physiology, 28(2), 240-256. <https://doi.org/10.1139/h03-017>
- Jentjens, R., & Jeukendrup, A. E. (2003). Determinants of postexercise glycogen synthesis during short-term recovery. Sports Medicine, 33(2), 117-144. <https://doi.org/10.2165/00007256-200333020-00004>
- Juliff, L. E., Peiffer, J. J., & Halson, S. L. (2018). Night games and sleep: Physiological, neuroendocrine, and psychometric mechanisms. International Journal of Sports Physiology and Performance, 13(7), 867-873. <https://doi.org/10.1123/ijspp.2017-0746>
- Kaesaman, N. (2019). The acute effect of traditional Thai massage on recovery from fatigue in basketball players. International Journal of Geomate, 2019, 16. <https://doi.org/10.21660/2020.51.104>
- Kara, E., & İnver, G. (2019). Massage and its effects on recovery. Gaziantep University Journal of Sport Sciences, 4(1), 28-49.
- Kılıç, T. (2010). Effects of basketball tournament on muscle damage and recovery time. (Unpublished doctoral dissertation). Gazi University, Institute of Health Sciences, Ankara.
- Koizumi, K., Fujita, Y., Muramatsu, S., Manabe, M., Ito, M., & Nomura, J. (2011). Active recovery effects on local oxygenation level during intensive cycling bouts. Journal of Sports Medicine and Physical Fitness, 29(9), 919-926.
- Köseoğlu, A., & Kin, A. (2008). The effect of leg massage applied at different durations on recovery after a supramaximal leg exercise. 10th International Sports Sciences Congress Abstract Book, 49.
- Lalor, B. J., Halson, S. L., Tran, J., Kemp, J. G., & Cormack, S. J. (2020). A complex

- relationship: Sleep, external training load, and well-being in elite Australian footballers. *International Journal of Sports Physiology and Performance*, 15(6), 777-787. <https://doi.org/10.1123/ijsp.2019-0431>
- Lane, K. N., & Wenger, H. A. (2004). Effect of selected recovery conditions on performance of repeated bouts of intermittent cycling separated by 24 hours. *Journal of Strength and Conditioning Research*, 18(4), 855-860. <https://doi.org/10.1519/00124278-200411000-00036>
- Lastella, M., Roach, G. D., Vincent, G. E., Scanlan, A. T., & Halson, S. L. (2020). The impact of training load on sleep during a 14-day training camp in elite, adolescent, female basketball players. *International Journal of Sports Physiology and Performance*, 15(5), 724-730. <https://doi.org/10.1123/ijsp.2019-0332>
- MacRae, B. A., Cotter, J. D., & Laing, R. M. (2011). Compression garments and exercise: Garment considerations, physiology and performance. *Sports Medicine*, 41(10), 815-843. <https://doi.org/10.2165/11591420-000000000-00000>
- MacRae, M. B. A., Cotter, J. D., & Laing, R. M. (2011). Compression garments and exercise. *Sports Medicine*, 41(10), 815-843. <https://doi.org/10.2165/11591420-000000000-00000>
- Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep*, 34(7), 943-950. <https://doi.org/10.5665/SLEEP.1132>
- Malarranha, J., Figueira, B., Leite, N., & Sampaio, J. (2013). Dynamic modeling of performance in basketball. *International Journal of Performance Analysis in Sport*, 13(1), 31-41. <https://doi.org/10.1080/24748668.2013.11868628>
- Marques-Jimenez, D., Calleja-Gonzalez, J., Arratibel, I., Delextrat, A., & Terrados, N. (2016). Are compression garments effective for the recovery of exercise-induced muscle damage? A systematic review with meta-analysis. *Physiology & Behavior*, 153, 133-148. <https://doi.org/10.1016>
- McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences*, 13(5), 387-397. <https://doi.org/10.1080/02640419508732254>
- Mihajlovic, M., Cabarkapa, D., Cabarkapa, D. V., Philipp, N. M., & Fry, A. C. (2023). Recovery methods in basketball: A systematic review. *Sports*, 11(11), 230. <https://doi.org/10.3390/sports11110230>
- Monedero, J., & Donne, B. (2000). Effect of recovery interventions on lactate removal and subsequent performance. *International Journal of Sports Medicine*, 21(8), 593-597. <https://doi.org/10.1055/s-2000-8486>
- Montgomery, P. G., Pyne, D. B., Cox, A. J., Hopkins, W. G., Minahan, C. L., & Hunt, P. H. (2008a). Muscle damage, inflammation, and recovery interventions during a 3-day basketball tournament. *European Journal of Sport Science*, 8(5), 241-250. <https://doi.org/10.1080/17461390802251844>
- Montgomery, P. G., Pyne, D. B., Hopkins, W. G., Dorman, J. C., Cook, K., & Minahan, C. L. (2008). The effect of recovery strategies on physical performance and cumulative fatigue in competitive basketball. *Journal of Sports Sciences*, 26(11), 1135-1145. <https://doi.org/10.1080/02640410802003509>
- Mori, H., Ohsawa, H., Tanaka, T. H., Taniwaki, E., Leisman, G., & Nishijo, K. (2004). Effect of massage on blood flow and muscle fatigue following isometric lumbar exercise. *Medical Science Monitor*, 10(5), 173-178.
- Murray, A., Fullagar, H., Turner, A. P., & Sproule, J. (2018). Recovery practices in division collegiate athletes in North America. *Physical Therapy in Sport*, 32, 67-

73. <https://doi.org/10.1016/j.ptsp.2018.04.009>
- Narazaki, K., Berg, K., Stergiou, N., et al. (2009). Physiological demands of competitive basketball. *Scandinavian Journal of Medicine & Science in Sports*, 19(3), 425-432. <https://doi.org/10.1111/j.1600-0838.2008.00895.x>
- Naziroglu, M., Kilinc, F., Uguz, A. C., et al. (2010). Oral vitamin C and E combination modulates blood lipid peroxidation and antioxidant vitamin levels in maximal exercising basketball players. *Cell Biochemistry and Function*, 28(4), 300-305. <https://doi.org/10.1002/cbf.1657>
- Nedelec, M., McCall, A., & Carling, C. (2013). Recovery in soccer: Part recovery strategies. *Sports Medicine*, 43(1), 9-22. <https://doi.org/10.1007/s40279-013-0006-z>
- Noble, J. G., Lee, V., & Griffith, F. (2007). Therapeutic ultrasound: The effects upon cutaneous blood flow in humans. *Ultrasound in Medicine and Biology*, 33(2), 279-285. <https://doi.org/10.1016/j.ultrasmedbio.2006.09.006>
- Ogai, R., Yamane, M., Matsumoto, T., & Kosaka, M. (2008). Effects of petrissage massage on fatigue and exercise performance following intensive cycle pedaling. *British Journal of Sports Medicine*, 42(10), 834-838. <https://doi.org/10.1136/bjsm.2007.043604>
- Oliver, D. (2011). *Basketball on paper: Rules and tools for performance analysis*. University of Nebraska Press.
- O’Riordan, S. F., McGregor, R., Halson, S. L., Bishop, D. J., & Broatch, J. R. (2021). Sports compression garments improve resting markers of venous return and muscle blood flow in male basketball players. *Journal of Sport and Health Science*, 10(5), 527-533. <https://doi.org/10.1016/j.jshs.2020.07.002>
- Packer, L. (1991). Protective role of vitamin E in biological systems. *American Journal of Clinical Nutrition*, 53(4), 1050S-1055S. <https://doi.org/10.1093/ajcn/53.4.1050S>
- Peifei, G., Linhuan, Z., Ximing, Z., & Xin, Z. (2021). Effects of post-exercise recovery methods on exercise-induced hormones and blood fatigue factors: A systematic review and meta-analysis. *Annals of Palliative Medicine*, 10(1), 184-193. <https://doi.org/10.21037/apm-20-1691>
- Powell, J., Dileo, T., Roberge, R., Coca, A., & Kim, J. H. (2015). Salivary and serum cortisol levels during recovery from intense exercise and prolonged, moderate exercise. *Biology of Sport*, 32(2), 91-95. <https://doi.org/10.5604/20831862.1140429>
- Rutkove, S. B. (2001). Effects of temperature on neuromuscular electrophysiology. *Muscle and Nerve*, 24(7), 867-882. <https://doi.org/10.1002/mus.1098>
- Sahlin, K. (1992). Metabolic factors in fatigue. *Sports Medicine*, 13(2), 99-107. <https://doi.org/10.2165/00007256-199213020-00004>
- Sargent, C., Lastella, M., Halson, S. L., & Roach, G. D. (2021). How much sleep does an elite athlete need? *International Journal of Sports Physiology and Performance*, 16(11), 1-12. <https://doi.org/10.1123/ijsp.2021-0074>
- Schroder, H., Navarro, E., Mora, J., et al. (2002). The type, amount, frequency, and timing of dietary supplement use by elite players in the first Spanish basketball league. *Journal of Sports Sciences*, 20(4), 353-358. <https://doi.org/10.1080/026404102753576091>
- Sen, C. (2000). *Basketball technique*. Bagirgan Publishing House.
- Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. *Journal of Sports Sciences*, 24(9), 919-932. <https://doi.org/10.1080/02640410500457109>
- Sporer, B. C., & Wenger, H. A. (2003). Effects of aerobic exercise on strength performance

- following various periods of recovery. *Journal of Strength and Conditioning Research*, 17(4), 638-644. [https://doi.org/10.1519/1533-4287\(2003\)017<0638](https://doi.org/10.1519/1533-4287(2003)017<0638)
- Staunton, C., Gordon, B., Custovic, E., Stanger, J., & Kingsley, M. (2017). Sleep patterns and match performance in elite Australian basketball athletes. *Journal of Science and Medicine in Sport*, 20(8), 786-789. <https://doi.org/10.1016/j.jsams.2017.02.003>
- Stojanovic, E., Stojiljkovic, N., Scanlan, A. T., Dalbo, V. J., Berkemans, D. M., & Milanovic, Z. (2018). The activity demands and physiological responses encountered during basketball match-play: A systematic review. *Sports Medicine*, 48(1), 111-135. <https://doi.org/10.1007/s40279-017-0794-z>
- Taylor, J. L., Amann, M., Duchateau, J., Meeusen, R., & Rice, C. L. (2016). Neural contributions to muscle fatigue: From the brain to the muscle and back again. *Medicine and Science in Sports and Exercise*, 48(11), 2294-2306. <https://doi.org/10.1249/MSS.0000000000000923>
- Tessitore, A., Meeusen, R., & Cortis, C. (2007). Effects of different recovery interventions on anaerobic performances following preseason soccer training. *Journal of Strength and Conditioning Research*, 21(3), 745-750. <https://doi.org/10.1519/00124278-200708000-00025>
- Uygur, M., Goktepe, A., Ak, E., Karab^rk, H., & Korkusuz, F. (2010). The effect of fatigue on the kinematics of free throw shooting in basketball. *Journal of Human Kinetics*, 24, 51-56. <https://doi.org/10.2478/v10078-010-0006-7>
- Vaile, J., Gill, N., & Blazevich, A. J. (2007). The effect of contrast water therapy on symptoms of delayed onset muscle soreness (DOMS) and explosive athletic performance. *Journal of Strength and Conditioning Research*, 21(3), 697-702. <https://doi.org/10.1519/R-20726.1>
- Vaile, J., Halson, S., Gill, N., & Dawson, B. (2008). Effect of hydrotherapy on recovery from fatigue. *International Journal of Sports Medicine*, 29(7), 539-544. <https://doi.org/10.1055/s-2007-989267>
- Vural, M. (2019). Investigation of the Correlation between Knee Isokinetic Strength and Static-Dynamic Strength. *Journal of Social and Humanities Sciences Research*, 6(44), 3440-3446.
- Walsh, N. P., Halson, S. L., Sargent, C., Roach, G. D., Nedelec, M., Gupta, L., et al. Sleep and the athlete: Narrative review and 2021 expert consensus recommendations. *British Journal of Sports Medicine*. <https://doi.org/10.1136/bjsports-2020-102025>
- Warren, C., Landers, M., & Szymanski, D. (2014). Effects of three recovery protocols on range of motion, heart rate, rating of perceived exertion, and blood lactate in baseball pitchers during a simulated game. *Journal of Strength and Conditioning Research*, 29(11), 3016-3025. <https://doi.org/10.1519/JSC.0000000000000960>
- West, D., Cunningham, D., Bevan, H., Crewther, B., Cook, C., & Kilduff, L. (2013). Influence of active recovery on professional rugby union player's ability to harness postactivation potentiation. *Journal of Sports Medicine and Physical Fitness*, 53(2), 203-208.
- Wilcock, I. M., Cronin, J. B., & Hing, W. A. (2006). Water immersion: Does it enhance recovery from exercise? *International Journal of Sports Physiology and Performance*, 1(3), 195-206. <https://doi.org/10.1123/ijspp.1.3.195>
- Williams, C., & Rollo, I. (2015). Carbohydrate nutrition and team sport performance. *Sports Medicine*, 45(Suppl 1), S13-S22. <https://doi.org/10.1007/s40279-015-0399-3>
- Yu, K., Su, Z., & Zhuang, R. (2008). An exploratory study of long-term performance

- evaluation for elite basketball players. *International Journal of Sports Science and Engineering*, 2(4), 195-203. <https://doi.org/10.16914/ijssse>
- Zinner, C., Pelka, M., Ferrauti, A., Meyer, T., Pfeiffer, M., & Sperlich, B. (2017). Responses of low and high compression during recovery after repeated sprint training in well-trained handball players. *European Journal of Sport Science*, 17(10), 1304-1310. <https://doi.org/10.1080/17461391.2017.1381760>
- Ziv, G., & Lidor, R. (2009). Physical attributes, physiological characteristics, on-court performance and nutritional strategies of female and male basketball players. *Sports Medicine*, 39(7), 547-568. <https://doi.org/10.2165/00007256-200939070-00003>

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