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STRATEGIES TO MANAGE STRESS AND FATIGUE IN ATHLETES

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ABSTRACT

High level athletes frequently travel for competition, participate in heavy training loads, have dense competitive schedules, and have to manage pressure to perform. All of these are sources of stress and if not strategically managed could lead to fatigue, decreased performance, and increased risk for injury. The purpose of this review is to provide the reader scientifically based strategies to manage stress and promote performance. Specific attention will focus on the influence of travel, sleep, and training load.

Keywords: fatigue; performance; injury; travel; sleep; training load

INTRODUCTION

The competitive schedule in collegiate and professional sport continues to increase. With dense competitive schedules the amount of travel increases and number of rest days decreases which in turn increases the chance of fatigue (1). For example, professional soccer players may have to play one or more matches per week in the final stage of the champion's league and then immediately fly more than 10 hours to Asia to join their national team and play matches in Japan (2). American professional basketball players travel to and from each coast to play games during the competitive season. Frequent travel means more time spent sleeping away from home, altered sleeping schedule and change to normal daily routines which can be stressful (3).

Fatigue has been defined as a "reduced capacity for force development" or "a response that is less than the expected or anticipated contractile response, for a given stimulation" (4). Fatigue is believed to be both physical and mental with physical fatigue felt as a lack of energy or strength and is often felt in the muscles and mental fatigue is a subjective sensation characterized by lack of motivation and alertness (5). Fatigue can be acute or chronic, chronic fatigue is defined as fatigue persisting for over six months and acute fatigue lasting less than six months (6). Fatigue can be central or peripheral, central fatigue is a progressive exercise-induced failure of voluntary activation of the muscle and peripheral fatigue refers to exercise-induced processes that leads to a reduction in force production that occurs at or distal to the neuromuscular junction (7). Fatigue appears to be a multifaceted and a complex phenomenon so no one definition is universally accepted.

Improvement in performance requires high levels of training loads which results in a certain amount of expected fatigue. If rest between consecutive workouts is optimal, then performance could increase as soon as the next training session or competition (8). Unfortunately in high level athletics, this does not happen due to so many competitions and dense travel schedules (9).

The aim of this article is to address specific factors which contribute to fatigue and provide strategies for managing this stress.

TRAVEL CAN BE STRESSFUL

Travel is common in competitive sport especially at the highest level. Travel can be stressful, draining, and uncomfortable, especially during longer trips (10). Imagine you are fixed in a seat for an extended period of time anxious about the trip and upcoming competition. The good news is most travel stress and fatigue can be reversed with relatively short periods of rest and appears to have non-significant effects on human physical performance. (11).

The physical strain and disruption to one's daily routine often results in negative symptoms, especially following long-haul air travel (12). The amount of travel fatigue depends on the length of the trip, number of time zones crossed, direction of travel (east and west coast) and the severity of fatigue is specific to the individual (13). Short haul travel without crossing time zones may result in symptoms of travel fatigue but do not have a significant effect on performance. Short haul travel did not impact elite rugby player's ability to perform strength and power tasks (14). Long haul travel (greater than 8 h without crossing time zones), such as a flight from New York to Lima (no time difference) could result in symptoms of fatigue which can be reversed with one day's rest and will not significantly affect physical performance (15).

Long haul travel (greater than 8 h) crossing time zones adversely affects exercise performance (16),especially for those who cross more than 10 time zones (a flight from the UK to the east coast of Australia) (17). Reductions in sport performance is likely due to fatigue as a result of general tiredness, sleep disruption, loss of concentration, loss of appetite, headaches, and general illness (18-20). For travel across more than 10 time zones, symptoms of fatigue can last over a week. This type of fatigue is associated with "jet lag" which is a disruption to circadian rhythm. This disruption occurs when an individual experiences an alteration to the external cues that synchronize the body's internal clock and biological circadian rhythmicity (3).

There exists a controversy about which is more detrimental to performance, an eastward flight (Australia to USA) or a westward flight (Australia to UK). Lemmer and colleagues reported greater sleep disturbance which persisted up to seven days after arrival from an eastward flight when compared to travel westward (21). The authors' contributed this to the body's internal clock which is naturally longer than the 24 hour light-dark cycle (22). Therefore, it is easier for the body to adapt to changes that lengthen the day as opposed to shorten (19). In contrast, Reilly et al. reported diminished performance when teams competed in the evening after travelling westward. This was most likely due to the competition being played closer to the visiting teams' home bed-time (23). This phenomenon has also been observed in American football (24), baseball, and basketball (25). Based on previous research, impaired performance is more a result of the time of the competition then actual flight direction (3). A second concern with travel is the possible increase in the incidence of injuries. Kara and colleague reported a trend in increased incidence of match-related non-contact soft tissue injuries after long-haul travel (more than five hours), but could not provide definitive evidence because of limited data (26).

MORE IS NOT ALWAYS BETTER

Increasing training load (TL) or time spent training does not automatically lead to increases in performance. Linear increases in TL without planed rest or unloading may actually lead to symptoms of overtraining (OTS) and reduced performance (Foster, 1998ab). The relationship between TL and performance may look more like an inverted-U (27, 28). This means too little training results in suboptimal performance but too much could result in decreases in performance.

A recent review examining the relationship between TL, injury rate, and immunity suggests an athlete's response to training needs to be monitored especially when a spike in training occurs or a sudden significant increase in the number of competitions (29). Measures of heart rate, oxygen consumption and lactate are effective and objective ways to asses an athlete's response to training and readiness for competition. Subjective measures of perceived stress, recovery, and exertion can be used to evaluate an athletes' response to TL. The Profile of Mood States (POMS) is a 65-item questionnaire in which responses are rated from a scale of 1 (not at all) to 4 (extremely). It provides a self-assessment of mood and affective state (i.e., anxiety, depression, fatigue, inertia) (30). Rating of Perceived Exertion (RPE) is another tool used to measure or evaluate effort during training. The RPE scale ranges from 6 to 20, six represents no exertion and twenty represents maximal exertion. A strong correlation between a person's perceived exertion score and heart rate during physical activity has been reported in the literature. For example if a person's RPE is a 20, then their heart rate should be approximately 200 (20 x 10 =200) beats per minute (31). The Recovery-Stress Questionnaire for Athletes (RESTQ-SPORT) is a self-report measure of stress and recovery. Higher scores on stress scales indicate the athlete is experiencing high levels of perceived stress, whereas high scores on recovery scales indicate the athlete feels recovered (32).

Game schedule or number of competitions played per week can be viewed just like training load. When competition density (number of games per week) is high this can reduce time spent on recovery and increase chance for injury (33). When recovery time between competitions is reduced, lack of motivation and mental burnout may occur (34). Match performance in elite soccer players fluctuated across the season but was improved when game density was lower (35). Lago-Peñas (2012) reported a drop in physical performance during match play when player's recovery time was lower between games due to number of games. Gabbett and Jenkins (2011) reported higher training loads during strength and power training contributed indirectly to field injuries. Research suggests a

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strong relationship between training injury and training intensity, duration, and load. An increase in training load, particularly during the pre-season, significantly increases the risk for injury during the competitive season (36). (29).

Injuries are also associated with game intensity and competition density. For example, soccer players covered significantly higher distances during the weeks preceding an injury (37). This is in line with previous research that reported the occurrence of match injury was significantly correlated with match intensity, duration and load (38). Injury rate was significantly higher when players played two matches per week versus one match (39).

SLEEP AND PERFORMANCE: MORE IS BETTER

Lack of sleep may lead to decreases in sport performance (40). With sleep loss, there is a hormone imbalance in the autonomic nervous system which results in similar symptoms seen in overtraining. Modest amounts of sleep deprivation have been linked with negative mood state and impaired reaction time (41). Sleep quantity of at least 10 h each night directly enhances sport performance markers such as timed sprint and shooting in basketball (42). Sleep quantity also influences chance for injury. Injuries have been reported to be related to less than 6 hours of sleep the night before the injury (43). In a second study, investigators reported the likelihood for injury was 1.7 times higher for athletes who slept less than 8 hours per night when compared to those who slept more than 8 hours per night (44).

Unlike sleep quantity (duration in bed), sleep quality includes quantifiable components such as sleep latency, sleep time, number of awakenings while in bed, and subjective indices of sleep, such as deep or light sleep, how well rested one feels after awakening, and general satisfaction with sleep (45). Sleep quality appears to be related to factors like health, fatigue, feelings of tension, and depression (45). Lower performance due to a lack of sleep has been reported in endurance exercise (46), sprinting and shooting performance in basketball (42), and ballet dancing (48). During a night's sleep we go through alternating sleep phases of non-rapid eye movement (NREM) and rapid eye movement (REM). The final stages of non-REM sleep are considered the deepest and most restorative form of sleep. It tends to occur more between 10 pm and 2 am of your 'internal clock' or home time zone. If two athletes sleep the same amount in a night, the athlete that goes to bed at 10 pm versus 2 am is more likely to have a more restful and restorative night's sleep because of time spent in NREM (49). There are many factors that affect an athlete's sleep quality. One factor is tension due to competition, a study examining elite Australian athletes reported 64% suffered reduced sleep quality before an important competition due to nervous thoughts regarding the event (50). Time of competition can be very disruptive to sleep quality. If an athlete from the east coast is playing a night game on the west coast, it could push bed time to 5am based on their "internal clock", and well past the window of restorative sleep. Conversely, a west coast team playing at night on the east coast is not affected due to staying within their normal bedtime based on their internal clock.

There are multiple methods to measure sleep quality. The Stanford Sleepiness Scale (SSS) has the subject rate their current sleepiness on a seven-point scale, where the Epworth Sleepiness Scale (ESS) has the subject rank their current chance of falling asleep when they imagine themselves in eight different situations (45). Recently, smartphone sleep apps have been used to measure sleep quality, the validity has been reported to be poor due to variability of phone type and position of the device when recording data (51). The Pittsburgh Sleep Quality Index (PSQI), which contains ten different questions that address normal sleep habits, appears to be the most popular method to measure sleep quality; however it is more of a psychological measure and sleep diary (52).

HOW DID THAT FEEL? PERCEIVED STRESS AND RECOVERY

Whether it is training or competition, athletes face all types of stress. One of the most challenging is the stress of performing (53). Similar to Tl, the stress associated with game performance can be described as an inverted-U, meaning there is an optimal level of performance stress that induces positive physical performance, when stress is too high or too low physical performance suffers (54). High levels of competitive stress can result in cognitive and somatic anxiety resulting in mental fatigue. This type of fatigue contributes to lower levels of physical performance (55)(56).

Match outcome may contribute to post-competition stress and fatigue due to the mental strain and stress associated with losing (57). For example, players on the losing team would most likely experience a higher level of fatigue and a lower mental state of wellbeing compared to athletes on the winning team. This phenomenon linking match outcome and perception of fatigue has been observed in football, basketball and soccer (58-60). In order to manage the influence of game outcome on fatigue and recovery, mood state and psychological wellbeing should be monitored. These can be measured with the RESTQ-76, RPE, or any established measure of perceived stress and recovery.

PRACTICAL RECOMMENDATIONS

Training and competing in sport is stressful and this stress cannot be avoided but maybe it can be managed in a way to reduce the amount of stress experienced by the athlete. The aim of this section is to provide the reader, based on previous research, practical strategies to manage stress and fatigue. In general, attention needs to be focused on strategies that are accessible and feasible. In the previous sections we tried to provide background information on areas that most athletes and coaches can target to manage stress. These included: sleep quantity and quality, monitoring training and competition load, measuring perceived recovery and stress. In the following section we hope to provide some practical strategies to monitor and manage stress.

Monitoring training load

Training load can be considered as either external or internal load. External load is related to the work completed and can be monitored for example by measuring power output or by time-motion analysis. Internal load is more related to physiological and psychological stress and can be quantified by perception of effort, heart rate and blood lactate (61). Currently, there is no single measurement used to quantify an athlete’s response to training and predict an athlete’s readiness to compete. How an athlete responds to training is specific to the individual and therefore many factors influence how an individual responds to training and competition (62). Therefore, multiple tests of both external and internal load are suggested and most likely necessary to evaluate and

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monitor an athlete’s response to training, competition, and other stressors encountered across a season (61, 63).

Strategies for sleep hygiene

Sleep is the most accessible and cost effective recovery strategy that appears to have a significant impact on sport performance. Sleep quantity needs to be at least 7 hours a night and bedtime needs to be based on the athlete’s internal clock targeting 10 pm – 2 am because of NREM. If possible, sleep quantity of 10 h per night will likely enhance sport performance. To promote sleep quality, a quiet environment and dark room is recommended with one light source and a room temperature at 18 degrees centigrade. Athletes should avoid caffeine and the use of their computer, tablet, and watching television before bed time. Napping should be used to make up for sleep lost during the night before or for recovery purposes between training sessions. Naps should last 30 minutes and should be taken not later than midafternoon (64). In order to enhance sleeping quality, nutritional interventions are also recommended, such as consuming small doses of tryptophan, melatonin and foods that have a high melatonin concentration like Pineapples, Bananas, or valerian tea (65).

Tips for travel

When making travel plans athletes and coaches can implement strategies to potentially reduce travel stress. Planning to arrive at least 3-5 days before competition will allow the body’s internal clock to adjust to local time. In preparation for a long trip athletes can advance the time on their watch or phone 1 to 2 hours two days before a long flight eastward. During these two days athletes would eat and sleep 1 to 2 hours earlier then their normal schedule. For flights westward, the clock would be set 1 or 2 hours later (66). Strategies to be implemented during a plane flight include monitoring hydration levels by examining urine color, ingest water over and above normal intake, and obtain some physical activity such as walking to the restroom and back each hour of sitting (16). After arriving to their destination athletes should ingest a breakfast high in protein and an evening meal high in carbohydrate. Athletes should focus on engaging in physical activity outdoors to promote exposure to natural light which helps to reset the inner clock. If arrival is at night, athletes should avoid any kind of artificial light (67). In addition, prolonged naps (more than 30 minutes) after changing time-zones are not advised because it could prolong the adjustment to the time change (67). Consumption of melatonin is recommended, because it may reduce symptoms of jet lag after a long flight, improves sleep quality, and does not have the “hangover” effect on performance compared to other sleep aide products (68). Wearing compression garments during air travel and post 24 hours may help with recovery from air flight stress (69).

Nutritional strategies

Nutrition is important for managing stress. Athletes need to consume adequate amounts of both carbohydrates and protein to meet the demands of training and promote post training recovery. Carbohydrate intake is needed before exercise at levels tolerable to the athlete’s digestive system; during long-duration moderate intensity activity, a 6%

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CHO liquid solution should be given every 15 minutes; after exercise, an intake of 1.5g/kg of body weight of CHO immediately is recommended. (70). Both aerobic and anaerobic athletes benefit from the combined ingestion of CHO and protein post-exercise to promote muscle glycogen synthesis and skeletal muscle damage repair and reconditioning. Ingestion of ~20g dietary protein five or six times daily post-exercise has been reported to be sufficient to maximize muscle protein synthesis (71). Water intake before, during, and following training or competition is recommended to ensure good performance, therefore monitoring hydration levels is critical for athletes. Monitoring urine color or using urine strips (urine specific gravity) is recommended because it is practical and cost effective (72).

Perceived stress and fatigue is reported by athletes during periods of heavy training and dense competition schedules. Branched-Chain Amino Acid (BCAA) may reduce mental fatigue during exercise and improve cognitive and physical performance. Oral supplementation of 100 to 300 mg coenzyme Q10 per day or 3-9 grams BCAA per 100 pounds lean bodyweight per day may be helpful with managing fatigue (73, 74). It has been reported that the intake of n-3 polyunsaturated fatty acids (PUFA) play an important role in reducing post exercise fatigue, relieving DOMS and promoting immune function (75) therefore, the intake of a minimum of 2 servings of fatty fish (8 oz) per week is recommended (70).

The Recovery Plan

A self-monitoring method called "recovery action plan" promotes or motivates athletes to perform recovery modalities which have pre-determined recovery points (RPs) (76). These plans allow recovery to come from different resources based on the athlete's personnel preference. A recovery plan may include RPs from nutrition and hydration, sleep and rest, stretching and cool-down, and relaxation and emotional support (i.e. massage or music therapy) (76). For example, nutrition and hydration includes RPs for breakfast, lunch, and dinner. Each meal is encouraged to contain protein, carbohydrates along with fruits, veggies, and energy bars. For sleep and rest, high-quality sleep at night (measured by Pittsburgh Sleep Quality Index) and 30 minute naps are encouraged and awarded RPs. Performing stretching exercises and cool-down activities after each training session or competition will earn the athlete RP. Additional activities such as meditation, music therapy, massage, foam rolling techniques, and hot-cold baths are suggested to promote recovery and earn RPs. (76). These plans can be developed based on each individual athlete's preference for recovery. Allowing the athlete to pick and choose their recovery activities may increase the amount of time they dedicate to recovery and may increase the number of athletes utilizing recovery activities.

CONCLUSIONS

In conclusion, the management of stress is a crucial and often an overlooked aspect of sport and sport training. This is especially important during the pre and competitive seasons when training and competition density is high. The aim of the current paper was to provide strategies based on previous research to help manage stress. General recommendations include: periodized strength and conditioning programs, testing and monitoring of fitness levels and perceived stress and recovery, manage travel stress, focus on quality and quantity of sleep especially when away from home, attention to what you eat and drink, and develop a recovery plan that best suites you or your athletes.

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