Chapter 13:

Domestic and International Travel:
Implications for Performance and Recovery in Team-sport Athletes

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1. Introduction

Travel has long been synonymous with elite athletic competitions. For example, Australian and English cricket players undertook 45-day steamship journeys for competitive tours as early as the mid-1800's. The increased professionalism of sport and resulting congestion of competition and training demands has further increased the volume and extent of travel. Indeed, the modern professional athlete will have a multitude of travel commitments, ranging from regular short-haul domestic (and international) (< 5 h) through to long-haul international travel (> 20 h) for both training and competition needs (Fowler, Duffield, Howle, Waterson, & Vaile, 2015; Fowler, Duffield, & Vaile, 2014). Furthermore, professional teams often organise pre- and mid-season camps in various locations to utilise warm-weather or altitude training to accelerate training adaptations (Buchheit et al., 2013). As a result, travel is an additional stress imposed on professional players' competition and training schedules (Leatherwood & Dragoo, 2012). A vast array of potential stressors is imposed by travel, and accordingly the ability to tolerate and recover from air travel is potentially important for ensuing training or competition success. Accordingly, this chapter will draw upon a collection of recent studies on domestic and international travel in athletes to highlight both the consequences of travel on performance and recovery, whilst outlining strategies to ensure optimal post-flight performance.

Training and competition demands increase the physical and perceptual stress on athletes. Team sports often involve moderate-to-long duration efforts, during which players will undertake many brief, though intense efforts intermixed with rest and low-intensity activity (Bangsbo, Mohr, & Krustrup, 2006). Such demands can supress neuromuscular force and power, increase perceived fatigue and soreness and retard preparation for ensuing training and competition (Nédélec et al., 2012). Accordingly, recovery represents the return to baseline levels of performance, physiological and psychological functioning following competition or training bouts; and for many team sports, an optimal recovery timeframe suggested as being upwards of 72 h (Nédélec et al., 2012). Often this recovery process is expedited by a range of medical, physiological and mental interventions (Hausswirth & Le Meur, 2011). However, of importance is to avoid situations and conditions which may hamper the recovery process, and thus when athletes are required to travel before and after matches, a combination of factors may preclude optimal recovery circumstances.

In regards to recovery during a period requiring extensive travel, given the limited time between matches, short-haul air travel is often a necessity the day after an away match (Goumas, 2014). Time lost to travel and the ensuing disruption of routines and training schedules may inhibit the use of recovery and medical interventions. The preparation and recovery processes prior to and following away matches could therefore be impeded. Furthermore, the magnitude of travel completed by professional teams throughout a season can be substantial. For example, in Australian domestic competitions, football, rugby and soccer teams are required to travel up to ~ 3500 km across ≤ 3 time zones following matches (McGuckin, Sinclair, Sealey, & Bowmann, 2014; Richmond et al., 2007). Therefore, it has been proposed that frequent travel throughout a season may result in the summation of acute intangible effects of travel (Samuels, 2012). Moreover, since travel is often a requirement for teams the day after an away match, ensuing training loads and recovery may be disrupted, which in turn can affect player preparation. From an international perspective, long-haul travel results in symptoms of jet lag due to the misalignment of endogenous circadian rhythms (e.g., melatonin and body temperature) with the light-dark cycle of the destination (Waterhouse, Reilly, Atkinson, & Edwards, 2007). In addition, symptoms of travel fatigue are induced by the prolonged travel duration and cramped, hypoxic conditions of the cabin (Samuels, 2012). In turn, these conditions create problems with adequate sleep quantity and quality, appropriate hydration and nutritional intake, as well as prevent access to proper medical and physiotherapy practices. Thus, the combination of desynchronisation between internal circadian rhythms with the external environment, as well as impedance of recovery processes make long-haul travel an issue for most athletic groups.

Given travel is often highlighted as a reason for poor performance and recovery, supporting evidence of the effect of travel on recovery and ensuing performance in athletes is minimal. Whilst a collective of laboratory studies exists on non-athletic populations, more recently the effects of various travel demands on sports-specific performance have been reported. Accordingly, this chapter will draw upon a collection of recent studies on domestic and international travel in athletes to highlight both the consequences of travel on recovery and strategies to ensure optimal post-flight performance.

2. Conditions and effects of air travel

2.1 Travel fatigue

Travel fatigue results from exposure to the process and environments related to travel i.e., the regularity, duration and conditions of travel. Accordingly, the causes of travel fatigue may be numerous and varied depending on the extent of travel undertaken. For example, causes may include the prolonged exposure to mild hypoxia, cramped conditions and cabin noise (Forbes-Robertson et al., 2012; Waterhouse et al., 2007), and/or the disruption of routines as a result of travel, such as eating and sleeping patterns (Reilly et al., 2007). Symptoms of travel fatigue include, but are not limited to, general fatigue, confusion, irritability and headaches; though these are often rescinded with a sufficient night's sleep (Waterhouse, Reilly, & Edwards, 2004; Waterhouse et al., 2007). More explicit causes of travel fatigue include prolonged sitting in cramped conditions, which may reduce flexibility and mobility, induce deep venous thrombosis (Cesarone et al., 2003; Waterhouse et al., 2004), and together with noise from the plane engines and other passengers, may disrupt sleep during air travel (Forbes-Robertson et al., 2012; Waterhouse et al., 2002). Whilst the symptoms of travel fatigue are reported to be less severe than jet lag, both result in compromised physical and cognitive performance (Reilly et al., 2007).

In addition to the above, it has been suggested that the dry cabin air and low hypobaric pressure may cause hypohydration (Hamada et al., 2002; Reilly et al., 2007), and the reduced quality of the cabin air could impair immune function following prolonged exposure (Coste Van Beers, Bogdan, & Touitou, 2007; Schwellnus et al., 2012). Furthermore, prolonged exposure to mild hypoxia may reduce oxygen saturation (Geertsema, Williams, Dzendrowskyj, & Hanna, 2008), have a detrimental impact on sleep and exacerbate physiological and perceptual stress (Coste, Van Beers, & Touitou, 2009). A final consequence of travel involves the perceived stress associated with delays and embarking and disembarking formalities, such as checking in, baggage claim and security and customs clearance, which often result in negative perceptual and mood states (Reilly et al., 2007; Waterhouse et al., 2007).

2.2 Jet Lag

When multiple time zones are rapidly crossed during international air travel, a loss of synchrony occurs between the endogenous circadian rhythms and external cues of the new time zone (Waterhouse et al., 2007). Following transmeridian air travel, circadian rhythms initially retain their habitual rhythms of the place of departure. However, external factors in the new environment, particularly the light-dark cycle, act as zeitgebers (time-givers) and promote resynchronisation of the body clock to align with the new time zone (Forbes-Robertson et al., 2012). As a result, body temperature (Lemmer, Kern, Nold, & Lohrer, 2002; Reilly, Atkinson, & Budgett, 2001; Waterhouse et al., 2002) and hormonal circadian rhythms (Bullock, Martin, Ross, Rosemond, & Marino, 2007; Lemmer et al., 2002), along with the sleep-wake cycle (Beaumont et al., 2004) are disrupted. These changes induce the detrimental symptoms of jet lag (Forbes-Robertson et al., 2012; Reilly et al., 2007), such as increased daytime fatigue and irritability, reduced alertness and negative mood states, gastrointestinal disturbances, together with decreased interest in eating and difficulty sleeping; all of which are likely to suppress physical and cognitive performance (Reilly et al., 2007; Reilly & Waterhouse, 2009).

Symptoms of jet lag occur following long-distance air travel eastward or westward across times zones and tend to be more severe and longer lasting than those of travel fatigue (Reilly et al., 2007). Though this typically occurs when time zones are rapidly crossed during air travel (Waterhouse et al., 2004), symptoms of jet lag have also been noted following simulated time zone changes in the laboratory, highlighting that unlike travel fatigue, jet lag is not caused solely by the demands of travel (Waterhouse et al., 2007). One of the main reported symptoms is poor sleep, especially delayed sleep onset and early awakening after eastward and westward flights, respectively (Beaumont et al., 2004; Takahashi, Nakata, & Arito, 2002). It is proposed that symptoms are worse the greater the number of time zones crossed and if travelling east rather than west (Waterhouse et al., 2004). Indeed, rates of resynchronisation are loosely estimated as half a day per hour of the time difference westwards, or 1 day per hour of the time difference eastwards (Forbes-Robertson et al., 2012). The predicted faster rate of resynchronisation following westward travel is based on principles of chronobiology, suggesting it is easier to adapt to a phase delay following westward rather than a phase advance after eastward travel (Forbes-Robertson et al., 2012). However, it is accepted the above description is simplistic in nature and high inter-individual variation exists for jet lag symptoms and their severity. Furthermore, evidence of the rates of post-travel resynchronisation of circadian rhythms are also highly variable meaning explicit guides to overcoming jet lag are often generic in nature.

3. Performance and recovery following domestic or short-haul international travel

Short-haul domestic and international air travel is one of a myriad of factors purported to affect match outcome and the tendency for teams to perform better at home compared to away (Goumas, 2014; Pollard, 2008). Hence, it is frequently highlighted by the media, coaching staff and players as an explanation for poor away match performances (Du Preez & Lambert, 2009). As evidence, crossing a greater number of time zones during domestic air travel for away matches has been correlated with reduced competition performance (Bishop, 2004; Goumas, 2014; Winter, Hammond, Green, Zhang, & Bliwise, 2009). Moreover, the time of competition appears to be influential, with teams gaining an advantage if competition occurs closer to the time of peak physical performance, which is often biased against travelling teams (Leatherwood & Dragoo, 2012). The tendency for teams to perform better at home compared to away, referred to as the 'Home Advantage', is a consistent finding in a range of team sports (Gomez, Pollard, & Luis-Pascual, 2011). For example, situational variables such as match location and status, and opposition quality, together with territoriality, tactics, and the expectancy to perform worse away from home have been identified as the factors most likely to affect competition performance (Lago, Casais, Dominguez, & Sampaio, 2010; Neave & Wolfson, 2003). Whilst difficult to separate Home Advantage from the discreet effects of travel, three specific components of travel are thought to provide an advantage to the home team; including i) the disruption of familiar routines, ii) fatigue from travelling and iii) the distance travelled, which may also be inversely associated with crowd support (Smith, Ciacciarelli, Serzan, & Lambert, 2000). In particular, the disruption of familiar routines is the main aspect of travel thought to influence competition performance (Smith et al., 2000). For example, it is speculated that the home team may have physiological and psychological advantages over their opposition because they are able to reside at home rather than in an unfamiliar hotel, can sustain a regular sleep pattern as sleep is not affected by travel demands and/or jet lag, and can maintain normal diet and eating practices (Smith et al., 2000).

Several studies have attempted to determine whether travel is a major factor behind reduced away competition performance in team sports, though to date the evidence is equivocal. For example, separating travel effects through regression analyses on performance data from team sports has revealed that parameters such as distance travelled and number of time zones crossed may account for only 1 - 2 % of the variance in match outcome (Smith et al., 2000). However, in other studies, crossing a greater number of time zones during domestic air travel for away matches has been significantly correlated with reduced competition performance (Bishop, 2004; Winter et al., 2009). For example, a strong positive correlation between Home Advantage and the number of time zones crossed by away teams was observed in professional soccer players in Australia (Goumas, 2014). A limitation of this study was the relatively small number of matches involving away teams that had crossed more than two time zones. Further, in American Major League Baseball, when a match involved a team that had travelled across three time zones it resulted in a winning percentage of 61 % for the home team (Winter et al., 2009). Furthermore, it was reported that the probability of the home team winning depended on whether the away team had travelled east, and that the home team could expect to score 1.24 (0.79 - 1.69) more runs than usual when this occurred (Recht, Lew, & Schwartz, 1995). Collectively these findings imply that domestic air travel across time-zones may have a negative impact on competition performance and that west coast teams in Australia and America have the double handicap of playing their away games after travelling east across time-zones. However, no measures other than competition (scoreboard) performance are reported in these studies, and further more individualised measures of athlete responses are required to better understand the effects of domestic travel.

In order to isolate the effect of travel on physical performance in team sport athletes, Fowler, Duffield, and Vaile (2015) simulated a 5h domestic flight with mild hypoxia, seating arrangements, activity and sleep patterns typically encountered during air travel in a normobaric, hypoxic altitude room. Yo-Yo Intermittent Recovery test performance, sleeping patterns and mood states remained unchanged following a simulated 5h fight in sub-elite team sport athletes. More relevant are studies that investigate the effects of the demands of domestic air travel on technical and tactical performance indicators and team sport physical performance measures (McGuckin et al., 2014; Richmond et al., 2007). During away compared to home matches, professional rugby league players performed more tackles and covered less distance (McGuckin et al., 2014). Conversely, no differences in match statistics, including time between possessions and team assists, were evident in professional Australian Football League players (Richmond et al., 2007). From a physical capacity perspective, no change in grip strength or lower-body power was reported following short-haul air travel (McGuckin et al., 2014). Fowler and colleagues (2014) reported the effects of short-haul air travel on competition performance and subsequent recovery in professional soccer players from home and away matches against the same teams. Whilst oxygen saturation was significantly lower during travel, equivocal differences in sleep quantity and quality, hydration and perceptual fatigue were evident at away compared to home competition. Accordingly, despite poorer away match performances, the short-haul air travel may not explicitly be the reason, and thus situational variables and tactics may be more important.

Whilst the aforementioned studies report acute responses, i.e., within days of a singular bout of travel, it may be the accumulated demands of regular short-haul travel that are of concern for athletes during domestic competitions (Samuels, 2012). Fowler, Duffield, Waterson, and Vaile (2015) reported the effect of home vs. away during early vs. late competition periods on training loads, wellness and injury in a professional soccer team. Not surprisingly, training load distribution during the weekly micro-cycle was altered due to the demands of travel, particularly on the day after arrival from an away match. However, no discernible effect of travel was evident on player wellness due to match location (home *vs.* away) or injury occurrence, irrespective of period of the season. Whilst more training sessions were missed at home due to injury, this was a likely artefact of more sessions being completed during home match weeks. Accordingly, regular short-haul travel had negligible accumulative effects on player wellness or injury during a season. Given the previously outlined research in athletes, limited and equivocal evidence exists for the negative effects of domestic short-haul air travel on the recovery timeline of team sport athletes, though a more detailed understanding remains to be elucidated.

4. Performance and recovery following long-haul international travel

Current data on the performance capacity and timeline of recovery for athletes following long-haul travel is mixed and confusing. Understandably, substantial logistical issues and costs are associated with conducting research into the effects of international air travel on athlete performance and recovery. Consequently, there are limited field-based studies on the effects of an episode of international air travel on sports performance. Reduced grip strength is commonly reported following long-haul transmeridian air travel (Edwards et al., 2000; Reilly et al., 2001). For example, reduced grip strength was reported following 12 h of eastward air travel across eight time zones (Lemmer et al., 2002), together with nine and 10 h of westward air travel across five and six time zones in elite gymnasts (Lemmer et al., 2002; Reilly et al., 2001). Though, in contrast to the assumption that eastward has a greater impact on performance than westward travel, no differences in grip strength were reported for 4 of the athletes when comparing 12 h of eastward travel across eight time zones to 10 h of westward travel across six time zones (Lemmer et al., 2002). Admittedly due to its convenient and non-fatiguing nature, hand grip strength is a common measure of the circadian rhythm in muscle performance (Drust, Waterhouse, Atkinson, Edwards, & Reilly, 2005; Reilly et al., 2001). Whilst tests exhibiting these characteristics are preferable when assessing circadian rhythms in physical performance, the ecological validity of hand grip strength to performance in team sport training and competition is questionable.

Accordingly, jump performance is thought to be a non-fatiguing, yet time efficient and more specific team sport action, and thus may be a more appropriate measure. In elite skeleton athletes, reduced velocity, power, eccentric utilisation ratios, box drop jump flight time and contact time to flight time ratio, squat jump velocity and power, and countermovement jump height were observed in the first two days following 24 h of eastward transmeridian air travel across 15 time zones (Chapman, Bullock, Ross, Rosemond, & Martin, 2012). These results suggest that both skeletal muscle contractile and neuromuscular function, and therefore, jump performance are adversely affected by long-haul transmeridian air travel (Chapman et al., 2012). Conversely, no change in 30 m sprint performance was identified in the same participant population in response to the same travel demands (Bullock et al., 2007). Similarly, minimal disruptions to squat jump height and power output during a 15 s multiple jump test were reported following 10 h of eastward air travel across seven time zones in an active, but not athletic population (Lagarde et al., 2001). These contrasting results may be due to differences in travel demands, including the duration and distance of travel, and/or the sensitivity, type and timing of physical performance measures, making meaningful comparisons between studies difficult. These conflicting findings emphasise the equivocal effect of international air travel on physical performance. Such diverse findings could be a result of the varying degrees of success by which study designs have controlled for the multitude of confounding factors that affect sports performance (Leatherwood & Dragoo, 2012; Reilly & Waterhouse, 2009). However, it may also be explained by the inter-individual variation in responses to the different durations and directions of travel, due to age, flexibility of sleeping habits, time of arrival and previous travel experience (Waterhouse et al., 2002).

Recently, Fowler, Duffield, and Vaile (2015) simulated a 24h long-haul international flight in sub-elite team sport athletes. The mild hypoxia, seating arrangements, activity and sleep patterns typically encountered during air travel were replicated in a normobaric, hypoxic altitude room. Both sleep quantity and quality were reduced due to the simulated international flight, resulting in reduced intermittent-sprint performance (Yo-Yo test Level 1) on the day after the simulated flight. Further, negative mood states, perceived fatigue and autonomic function from steady-state heart rate responses were also exacerbated. A similar impact on sleep was reported in an elite team of footballers who undertook 18 h of westward international air travel with a 4 h time zone shift (Fullagar et al., 2016). Sleep duration and efficiency were reduced during and following outbound travel. However, these alterations were not dissimilar to the quantity and quality of sleep noted following ensuing night matches. Of interest, perceived jet lag and recovery was not affected by the flight duration or time zone shift, suggesting either the players were habituated to travel, or these travel demands were insufficient to cause significant alterations to player wellbeing (Fullagar et al., 2016). Therefore, it is possible that they may be able to cope or are familiar with the demands of travel more so than non-athletes, which may assist with explaining the different findings between studies involving different participant populations (Bullock et al., 2007).

Furthermore, a professional soccer team were monitored following 10h northbound air travel across one time zone for sleep, jet lag and wellness (Fowler, Duffield, Howle, et al., 2015). Sleep duration was reduced on the night prior to travel due to the early awakening to get to the airport, however was not unduly affected in the days thereafter. Subjective jet lag was increased and player wellness reduced during the days post-travel. Accordingly, despite minimal time zone change, some evidence for disrupted sleep and fatigue was evident. Such a response may be due to misinterpretation by younger, less experienced players who reported higher jet lag and lower wellness than their more experienced colleagues. Similarly, National team footballers who undertook eastward long-haul air travel across 11 time zones reported increased perceived jet lag for 4 days, poorer self-reported sleep duration both during travel and in the 4 days post-travel and a reduction in mean wellness during the week following travel (Fowler, McCall, Jones, & Duffield, in press). These results in National team footballers highlight the reduction in player preparedness for ensuing training and competition, despite the lack of explicit physical performance data. Finally, Fowler, Duffield, Lu, Hickmans, and Scott (2016) also reported the effects of 24 h travel westward across 11 time zones on subjective jet lag, sleep and wellness responses, together with self-reported upper-respiratory tract infection (URTI) symptoms in professional rugby league players. Self-reported sleep onset times and wake up times were earlier in the days following travel. Of interest, no effects of travel on wellness and muscle strength or range of motion were evident. However, an increase in URTI symptoms existed in the week after travel. The increase in URTI symptoms and severity conforms to earlier reports that athletes are at greater risk of URTI's when crossing >5 time zones away from their place of residence (Schwellnus et al., 2012). Accordingly, protection of athletes from foreign pathogens and immune system infection is integral for the health of travelling players. Again though, limited sport-specific performance measures were collected, so it remains unknown as to whether such factors from international travel reduce competition performance.

5. Interventions to improve post-travel readiness

As previously outlined, the demands of long-haul transmeridian air travel, combined with the detrimental consequences of jet lag, may induce adverse physiological, perceptual and sleep responses and in turn suppress physical performance (Chapman et al., 2012; Coste et al., 2009). Interventions to overcome these individual or collective effects would be advantageous for travelling team sport athletes. However, a paucity of interventions have been confirmed as beneficial to travelling athletes. Instead, based on an understanding of chronobiology from laboratory-based experiments (Deacon & Arendt, 1996; Revell et al., 2005), generic recommendations have been published to promote the resynchronisation of circadian rhythms and thus, minimise the negative effects of jet lag following international air travel in athletes (Arendt, 2009; Forbes-Robertson et al., 2012; Reilly et al., 2007). However, it is yet unclear whether or not these recommendations have any effect on the recovery of physical performance following travel, particularly in elite athletes.

Following long-haul transmeridian air travel, external cues referred to as zeitgebers (time-givers), are reported to gradually resynchronise endogenous circadian rhythms (Forbes-Robertson et al., 2012). Though natural light is the strongest of these external cues, exercise, meal timing and exogenous melatonin can also contribute to resynchronisation (Arendt, 2009; Forbes-Robertson et al., 2012). Jet lag symptoms persist until the circadian rhythms are aligned with the external cues of the destination, which theoretically takes approximately one day per time zone crossed (Forbes-Robertson et al., 2012). Whilst it has been recommended that athletes allow a sufficient number of days in a new time zone for the body clock to fully adjust prior to competition (Reilly et al., 2007), this is often not plausible due to training and competition schedules. As a result, travel frequently occurs relatively close prior to and/or following competition. A faster rate of adaptation to a new time zone would reduce the duration of jet lag symptoms and therefore, the possible suppression of physical performance (Arendt, 2009). Consequently, improving the rate of adaptation, which is the goal of the majority of travel interventions, within the logistics of travel could be beneficial for team sport athletes. Despite the lack of evidence, to accelerate the resynchronisation of the sleep-wake cycle, previous recommendations propose that during travel, sleep should be scheduled according to when it is night at the destination, and must be avoided when it is daytime at the destination (Reilly & Edwards, 2007; Waterhouse et al., 2004).

In contrast, several studies have investigated the use of specific pharmacological interventions including caffeine, short-acting benzodiazepine hypnotics and melatonin (Beaumont et al., 2004; Edwards et al., 2000; Reilly et al., 2001). Considering the suggested unwanted side-effects (Beaumont et al., 2004; Reilly et al., 2001) and medical concerns over the use of many pharmacological interventions, the appropriate timing of bright light and exercise is currently advocated as the simplest, most appropriate and effective method of adjusting circadian rhythms in athletes (Forbes-Robertson et al., 2012). Consequently, the commercial availability of portable artificial bright light sources, such as light boxes and light glasses, as a treatment for jet lag has recently increased. Whilst evidence suggests these devices may adjust circadian rhythms in well controlled laboratory studies (Wright, Lack, & Kennaway, 2004), their effectiveness at enhancing the recovery of physical performance following transmeridian air travel is limited (Boulos et al., 2002), particularly in elite team sport athletes (Thompson et al., 2013). Furthermore, as sleep disruption is likely during and following long-haul transmeridian air travel (Beaumont et al., 2004; Takahashi et al., 2002; Waterhouse et al., 2002), which may itself reduce ensuing physical performance, sleep interventions that minimise this disruption may also enhance performance recovery, though this remains to be investigated.

A further complication is the decision on whether or not to attempt to resynchronise circadian rhythms to the new time zone following international air travel. For short stays (1-2 days), attempts to resynchronise the body clock are not recommended (Forbes-Robertson et al., 2012). Instead, individuals are encouraged to stay on home time and schedule important events at the time of maximum alertness in the departure time zone (Arendt, 2009; Forbes-Robertson et al., 2012). However, this is logistically difficult in an applied setting, given it is not possible to adjust competition times to suit team sport athletes and the annoyance of not aligning behaviour with local times. Hence, the use of hypnotics (e.g., melatonin and benzodiazepines) and stimulants (e.g., caffeine) are sometimes advocated to reduce sleep disruption and maintain alertness and performance (Waterhouse et al., 2007). For longer stays (≥ 4 - 5 days) light exposure and/or exogenous melatonin administration are recommended to promote adaptation of circadian rhythms prior to departure and upon arrival to alleviate jet lag symptoms (Arendt, 2009; Forbes-Robertson et al., 2012). Indeed, a 'travel management program', which is a comprehensive approach to the management of jet lag and travel fatigue that includes pre-, during and post-travel periods (see Table 13.1), has been advocated for longer stays (Fowler, 2015; Samuels, 2012).

<TABLE 13.1 HERE>

6. Conclusion and recommendations for practice

Travel is an unavoidable stress for many high-performance athletes, whether it consists of regular short-haul or occasional long-haul travel. Accordingly, the ability to tolerate and recover from air travel is potentially important for ensuing training or competition success. Discounting the effect of Home Advantage, limited and equivocal evidence exists for the negative effects of domestic short-haul air travel, though the regularity of high volumes of such travel likely induce symptoms of travel fatigue across a season. A multitude of mechanisms result in long-haul international travel affecting ensuing physical performance and recovery, alongside exacerbated physiological, immunological and sleep responses. Regardless, appropriate planning and availability of strategies should be part of the practitioners' tool kit to deal with either the perceptual aspects of domestic travel fatigue, or the more physiologically onerous demands of long-haul travel. Either way, improving athlete perceptions, tolerance and preparation for travel is a must to ensure optimised post-travel performance and recovery.

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Table 13.1. Practical applications for optimal recovery following travel as adapted from those published by Fowler (2015).

1. Pre Travel
i. Undertake sleep hygiene practices prior to travel to minimise sleep debt.
ii. If feasible, replace long duration moderate intensity training (which may be immunosuppressive) with shorter, high intensity, high quality sessions.
iii. Consider immune-booster supplements ie. vitamin C, zinc acetate or gluconate to reduce the risk of illness.
2. During Travel
i. Attempt to sleep whenever possible, but particularly when it is night time at the place of destination
ii. Practice good sleep hygiene; - Minimise the use of light emitting electronic equipment. - Avoid caffeine. - Utilise eye masks, neck pillows, ear plugs and/or noise cancelling headphones. - Wear comfortable, loose fitting clothing.
iii. The air plane cabin is a 'high-risk' environment for infection/illness, therefore; - Don't self-inoculate by touching eyes, nose and mouth. - Avoid contact with most frequently touched area of door handles and avoid using the whole hand. - Cough and sneeze into the elbow not hands. - Practice good hand hygiene by washing them frequently and using a hand sanitiser with residual activity.
3. Post Travel
i. Physical performance may be reduced in the first few days (≤ 72 h) following arrival and adjust training load as appropriate.
ii. Practice good sleep hygiene; - Minimise the use of electronic equipment and dim room lights 1 h prior to bed. - Avoid caffeine approximately 4-5 h prior to sleep (this may vary between individuals). - Ensure cool (~19-21°C), quiet and dark conditions throughout the sleep period. Eye masks and ear plugs may be helpful, particularly with reinitiating sleep onset if early waking occurs. - Napping can be useful to counteract night time sleep disruption. However, naps should be kept to ≤ 1 h and not too close to bed time as this may interfere with sleep.
iii. Light exposure and training times; - Westward travel (phase-delay required) - seek light/exercise for the 2-3 h prior to core body temperature minimum (T_{min}; ~05:00 local time) & avoid light/exercise for the 2-3 h following T_{min}. - Eastward travel (phase-advance required) - avoid light/exercise for the 2-3 h prior to T_{min} & seek light/exercise for the 2-3 h following $T_{min.}$ - If the timing of light exposure is outside daylight hours or it is an overcast day, supplementing natural with artificial light may be beneficial. - Be wary of light exposure and training too close to bed time as this may interfere with sleep.
iv. Melatonin administration (3-5 mg has typically been used in field studies); - Westward travel - administration in the morning (body clock time) around the $T_{min.}$ - Eastward travel - administration in the evening (body clock time).
v. Caffeine administration; - Could be utilised to reduce sleepiness/increase alertness around training and competition.
vi. Take care with the dose and pharmokinetics of pharmacological interventions as they can induce negative side-effects and/or phase-shifts in the wrong direction.
vii. Due to potential side-effects, behavioural interventions (i.e. light exposure) should be preferred and prioritised over pharmacological, though use as is required under medical supervision.