Journal Scan

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1. Chronobiol Int. 2014 Dec;31(10):1160-8.

The impact of training schedules on the sleep and fatigue of elite athletes.

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In any sport, successful performance requires a planned approach to training and recovery. While sleep is recognized as an essential component of this approach,the amount and quality of sleep routinely obtained by elite athletes has not been systematically evaluated. Data were collected from 70 nationally ranked athletes from seven different sports. Athletes wore wrist activity monitors and completed self-report sleep/ training diaries for 2 weeks during normal training. The athletes also recorded their fatigue level prior to each training session using a 7-point scale. On average, the athletes spent 08:18 ± 01:12 h in bed, fell asleep at 23:06 ± 01:12 h, woke at 6:48 ± 01:30 h and obtained 06:30 ± 01:24 h of sleep per night. There was a marked difference in the athletes' sleep/wake behaviour on training days and rest days. Linear mixed model analyses revealed that on nights prior to training days, time spent in bed was significantly shorter (p = 0.001), sleep onset and offset times were significantly earlier (p<0.001) and the amount of sleep obtained was significantly less (p = 0 . 0 0 1) , than on nights prior to rest days. Moreover, there was a significant effect of sleep duration on pre-training fatigue levels (p d" 0.01). Specifically, shorter sleep durations were associated with higher levels of pre-training fatigue. Taken together, these findings suggest that the amount of sleep an elite athlete obtains is dictated by their training schedule. In particular, early morning starts reduce sleep duration and increase pre-training fatigue levels. When designing schedules, coaches should be aware of the implications of the timing of training sessions for sleep and fatigue. In cases where early morning starts are unavoidable, countermeasures for minimizing sleep loss - such as strategic napping during the day and correct sleep hygiene practices at night - should be considered.

2. Eur J Appl Physiol. 2014 Dec;114(12):2529-37.

Combined caffeine and carbohydrate ingestion: effects on nocturnal sleep and exercise performance in athletes.

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PURPOSE: In athletes, caffeine use is common although its effects on sleep have not been widely studied. This randomised, double-blind, placebo-controlled crossover trial investigated the effects of late-afternoon caffeine and carbohydrate-electrolyte (CEB) co-ingestion on cycling performance and nocturnal sleep.

METHODS: Six male cyclists/triathletes (age 27.5 ± 6.9 years) completed an afternoon training session (TS; cycling 80 min; 65% VO, max) followed by a 5 kJ kg(-1) cycling time trial (TT). Caffeine (split dose 2 × 3 mg kg(-1)) or placebo was administered 1 h prior and 40 min into the TS. A 7.4% CEB (3 ml kg(-1) every 15 min) was administered during the TS, followed 30 min after by a standardized evening meal. Participants retired at their usual bedtime and indices of sleep duration and quality were monitored via polysomnography.

DATA: mean ± SD.

RESULTS: All participants performed better in the caffeine TT (caffeine 19.7 ±3.3; placebo 20.5 ± 3.5 min; p = 0.006), while ratings of perceived exertion (caffeine 12.0 ± 0.6; placebo 12.9 ± 0.7; p = 0.004) and heart rate (caffeine 175 ± 6; placebo 167 ± 11 bpm; p = 0.085) were lower in the caffeine TS. Caffeine intake induced significant disruptions to a number of sleep indices including increased sleep onset latency (caffeine 51.1 ± 34.7; placebo 10.2 ± 4.2 min; p = 0.028) and decreased sleep efficiency (caffeine 76.1 ± 19.6; placebo 91.5 ± 4.2%; p = 0.028), rapid eye movement sleep (caffeine 62.1 ± 19.6; placebo 85.8 ± 24.7 min; p = 0.028) and total sleep time (caffeine 391 ± 97; placebo 464 ± 49 min; p = 0.028).

CONCLUSIONS: This study supports a performance-enhancing effect of caffeine, although athletes (especially those using caffeine for late-afternoon/evening training and competition) should consider its deleterious effects on sleep.

3. Appl Physiol Nutr Metab. 2014 Nov;39(11):1230-6.

Impact of 5-h phase advance on sleep architecture and physical performance in athletes.

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Travel across time zones causes jet lag and is accompanied by deleterious effects on sleep and performance in athletes. These poor performances have been evaluated in field studies but not in laboratory conditions. The purpose of this study was to evaluate, in athletes, the impact of 5-h phase advance on the architecture of sleep and physical performances (Wingate test). In a sleep laboratory, 16 male athletes (age: 22.2 ± 1.7 years, height: 178.3 ± 5.6 cm, body mass: 73.6 ± 7.9 kg) spent 1 night in baseline condition and 2 nights, 1 week apart, in phase shift condition recorded by electroencephalography to calculate sleep architecture variables. For these last 2 nights, the clock was advanced by 5 h.

Core body temperature rhythm was assessed continuously. The first night with phase advance decreased total sleep time, sleep efficiency, sleep onset latency, stage 2 of nonrapid eye movement (N2), and rapid eye movement (REM) sleep compared with baseline condition, whereas the second night decreased N2 and increased slow-wave sleep and REM, thus improving the quality of sleep. After phase advance, mean power improved, which resulted in higher lactatemia.

Acrophase and bathyphase of temperature occurred earlier and amplitude decreased in phase advance but the period was not modified. These results suggest that a simulated phase shift contributed to the changes in sleep architecture, but did not significantly impair physical performances in relation with early phase adjustment of temperature to the new local time.

4. Curr Psychiatry Rep. 2014 Aug;16(8):459.

The impact of sleep on soldier performance.

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The military population is particularly vulnerable to a multitude of sleep-related disorders owing to the type of work performed by active duty service members (ADSMs). Inadequate sleep, due to insufficient quantity or quality, is increasingly recognized as a public health concern. Traditionally, ADSMs have been encouraged that they can adapt to insufficient sleep just as the body adapts to physical training, but there is a substantial body of scientific literature which argues that this is not possible. Additionally, the military work environment creates unique challenges with respect to treatment options for common sleep disorders like obstructive sleep apnea, restless legs syndrome, and parasomnias. This review highlights sleep disorders which are prevalent in the modern military force and discusses the impact of poor sleep on overall performance. Medical treatments and recommendations for unit leaders are also discussed.

5. Sports Med. 2014 May;44 Suppl 1:S13-23.

Sleep in elite athletes and nutritional interventions to enhance sleep.

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Sleep has numerous important physiological and cognitive functions that may be particularly important to elite athletes. Recent evidence, as well as anecdotal information, suggests that athletes may experience a reduced quality and/or quantity of sleep. Sleep deprivation can have significant effects on athletic performance, especially submaximal, prolonged exercise. Compromised sleep may also influence learning, memory, cognition, pain perception, immunity and inflammation. Furthermore, changes in glucose metabolism and neuroendocrine function as a result of chronic, partial sleep deprivation may result in alterations in carbohydrate metabolism, appetite, food intake and protein synthesis. These factors can ultimately have a negative influence on an athlete's nutritional, metabolic and endocrine status and hence potentially reduce athletic performance. Research has identified a number of neurotransmitters associated with the sleep-wake cycle. These include serotonin, gamma-aminobutyric acid, orexin, melanin-concentrating hormone, cholinergic, galanin, noradrenaline, and histamine. Therefore, nutritional interventions that may act on these neurotransmitters in the brain may also influence sleep. Carbohydrate, tryptophan, valerian, melatonin and other nutritional interventions have been investigated as possible sleep inducers and represent promising potential interventions. In this review, the factors influencing sleep quality and quantity in athletic populations are examined and the potential impact of nutritional interventions is considered. While there is some research investigating the effects of nutritional interventions on sleep, future research may highlight the importance of nutritional and dietary interventions to enhance sleep.

6. Int J Sports Physiol Perform. 2014 Mar;9(2):273-82.

Recovery from repeated on-court tennis sessions: combining cold-water immersion, compression, and sleep recovery interventions.

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PURPOSE: To investigate the effects of combining cold-water immersion (CWI),full-body compression garments (CG), and sleep-hygiene recommendations on physical, physiological, and perceptual recovery after 2-a-day on-court training and match-play sessions.

METHODS: In a crossover design, 8 highly trained tennis players completed 2 sessions of on-court tennis-drill training and match play, followed by a recovery or control condition. Recovery interventions included a mixture of 15 min CWI, 3 h of wearing full-body CG, and following sleep-hygiene recommendations that night, while the control condition involved postsession stretching and no regulation of sleeping patterns. Technical performance (stroke and error rates), physical performance (accelerometry, countermovement jump [CMJ]), physiological (heart rate, blood lactate), and perceptual (mood, exertion, and soreness) measures were recorded from each on-court session, along with sleep quantity each night.

RESULTS: While stroke and error rates did not differ in the drill session ($P > .05$, $d < 0.20$), large effects were evident for increased time in play and stroke rate in match play after the recovery interventions ($P > .05$, $d > 0.90$). Although accelerometry values did not differ between conditions ($P > .05$, $d < 0.20$), CMJ tended to be improved before match play with recovery ($P > .05$, $d = 0.90$).

Furthermore, CWI and CG resulted in faster post session reductions in heart rate and lactate and reduced perceived soreness ($P > .05$, $d > 1.00$). In addition, sleep-hygiene recommendations increased sleep quantity ($P > .05$, $d > 2.00$) and maintained lower perceived soreness and fatigue ($P < .05$, $d > 2.00$).

CONCLUSIONS: Mixed-method recovery interventions (CWI and CG) used after tennis sessions increased ensuing time in play and lower-body power and reduced perceived soreness. Furthermore, sleep-hygiene recommendations helped reduce perceived soreness.

7. Am J Sports Med. 2014 Feb;42(2):472-8.

Baseline neurocognitive testing in sports-related concussions: the importance of a prior night's sleep.

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BACKGROUND: The management of sports-related concussions (SRCs) utilizes serial neurocognitive assessments and self-reported symptom inventories to assess recovery and safety for return to play (RTP). Because postconcussive RTP goals include symptom resolution and a return to neurocognitive baseline levels, clinical decisions rest in part on understanding modifiers of this baseline.

Several studies have reported age and sex to influence baseline neurocognitive performance, but few have assessed the potential effect of sleep. We chose to investigate the effect of reported sleep duration on baseline Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) performance and the number of patient-reported symptoms.

HYPOTHESIS: We hypothesized that athletes receiving less sleep before baseline testing would perform worse on neurocognitive metrics and report more symptoms.

STUDY DESIGN: Cross-sectional study; Level of evidence, 3.

METHODS: We retrospectively reviewed 3686 nonconcussed athletes (2371 male, 1315 female; 3305 high school, 381 college) with baseline symptom and ImPACT neurocognitive scores. Patients were stratified into 3 groups based on self-reported sleep duration the night before testing: (1) short, <7 hours; (2) intermediate, 7-9 hours; and (3) long, e"9 hours. A multivariate analysis of covariance (MANCOVA) with an á level of .05 was used to assess the influence of sleep duration on baseline ImPACT performance. A univariate ANCOVA was performed to investigate the influence of sleep on total self-reported symptoms.

RESULTS: When controlling for age and sex as covariates, the MANCOVA revealed significant group differences on ImPACT reaction time, verbal memory, and visual memory scores but not visual-motor (processing) speed scores. An ANCOVA also revealed significant group differences in total reported symptoms. For baseline symptoms and ImPACT scores, subsequent pairwise comparisons revealed these associations to be most significant when comparing the short and intermediate sleep groups.

CONCLUSION: Our results indicate that athletes sleeping fewer than 7 hours before baseline testing perform worse on 3 of 4 ImPACT scores and report more symptoms. Because SRC management and RTP decisions hinge on the comparison with a reliable baseline evaluation, clinicians should consider sleep duration before baseline neurocognitive testing as a potential factor in the assessment of athletes' recovery.

8. Eur J Appl Physiol. 2014 Feb;114(2):305-15.

A 20-min nap in athletes changes subsequent sleep architecture but does not alter physical performances after normal sleep or 5-h phase-advance conditions.

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PURPOSE: The aim of the study was to examine the effects of a post-prandial 20 min nap on a short-term physical exercise and subsequent sleep in athletes keeping their usual sleep schedules and in 5-h phase-advance condition.

METHODS: Sixteen healthy young male athletes (age 22.2 ± 1.7 years, non-habitual nappers) participated in the study. After a baseline 8-h time in bed in normal and 5-h advanced sleep schedules, a standardized morning and lunch in a laboratory environment, subjects underwent either a nap (20 min of sleep elapsed from 3 epochs of stage 1 or 1 epoch of stage 2), or a rest without sleep by lying in a bed, between 13:00 and 14:00 hours in non-shifted condition or 08:00 and 09:00 hours in shifted condition, after which anaerobic exercises were performed twice 2 h apart. Core body temperature was recorded throughout the study period.

RESULTS: The nap extended sleep onset latency from 6.72 ± 3.83 to 11.84 ± 13.44 min, after shifted condition but did not modify sleep architecture of the post-trial night among athletes, whether shifted or not. Moreover, napping did not improve physical performance but it delayed acrophase and batyphase of core body temperature rhythm parameters.

CONCLUSION: Napping showed no reliable benefit on short-term performances of athletes exercising at local time or after a simulated jet lag.

9. Lung. 2014 Feb;192(1):175-84.

Effects of exercise training on sleep apnea: a meta-analysis.

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BACKGROUND: Several studies have shown a favorable effect of supervised exercise training on obstructive sleep apnea (OSA). This meta-analysis was conducted to analyze the data from these studies on the severity of OSA (primary outcome) in adults. Secondary outcomes of interest included body mass index (BMI), sleep efficiency, daytime sleepiness and cardiorespiratory fitness.

METHODS: Two independent reviewers searched PubMed and Embase (from inception to March 6, 2013) to identify studies on the effects of supervised exercise training in adults with OSA. Pre- and postexercise training data on our primary and secondary outcomes were extracted.

RESULTS: A total of 5 studies with 6 cohorts that enrolled a total of 129 study participants met the inclusion criteria. The pooled estimate of mean pre- to postintervention (exercise) reduction in AHI was "6.27 events/h (95 % confidence interval [CI] -8.54 to -3.99; p < 0.001). The pooled estimates of mean changes in BMI, sleep efficiency, Epworth sleepiness scale and VO2 peak were -1.37 (95 % CI "2.81 to 0.07; p = 0.06), 5.75 % (95 % CI 2.47-9.03; p = 0.001), -3.3 (95 % CI -5.57 to -1.02; p = 0.004), and 3.93 mL/kg/min (95 % CI 2.44-5.42; p < 0.001), respectively.

CONCLUSIONS: This meta-analysis shows a statistically significant effect of exercise in reducing the severity of sleep apnea in patients with OSA with minimal changes in body weight. Additionally, the significant effects of exercise on cardiorespiratory fitness, daytime sleepiness, and sleep efficiency indicate the potential value of exercise in the management of OSA.

10. Eur J Sport Sci. 2014;14 Suppl 1:S123-30.

Athletes' precompetitive sleep behaviour and its relationship with subsequent precompetitive mood and performance.

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This investigation examined precompetitive sleep behaviour of 103 athletes and how it relates to precompetitive mood and subsequent performance. Results revealed that on the night before competition athletes slept well under the recommended target of eight hours of sleep for healthy adults, with almost 70% of athletes experiencing poorer sleep than usual. It was found that anxiety, noise, the need to use the bathroom and early event times were amongst the most commonly reported causes of disrupted sleep in athletes on the night prior to competition.

The negative moods of fatigue and tension were both significantly negatively correlated with precompetitive relative sleep quality (r = -0.28, P = 0.004, r = -0.21, P = 0.030, respectively) and total sleep time (r = -0.23, P = 0.023, r = -0.20, P = 0.044, respectively). Additionally, tension was positively correlated with number of awakenings (r = -0.20, P = 0.045). Vigour was seen to be significantly positively associated with relative sleep quality (r = 0.24, P=0.013). The relationships between relative sleep quality and fatigue, tension and vigour accounted for approximately 4 - 5% of the variance in mood scores. Disrupted sleep did not demonstrate any significant relationship with relative sporting performance. Conclusions from the present investigation are that athletes may be at particular risk of disrupted sleep on the night prior to competition, and this disruption can negatively relate to an athlete's precompetitive mood states.

11. Eur J Sport Sci. 2014;14(5):393-402.

Brainwave entrainment for better sleep and post-sleep state of young elite soccer players - a pilot study.

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The effect of sleep deprivation on psychophysical performance and well-being is comprehensively investigated. Research investigating the effect of improved sleep is rare. Just as little exists about attempts to support athletic mental state and performance by

improving sleep quality. This study aims to investigate whether sleep quality of top athletes can be improved by auditory brainwave entrainment and whether this leads to enhancements of post-sleep psychophysical states. In a pilot study, 15 young elite soccer players were stimulated for eight weeks during sleep with binaural beats around 2-8 Hz. Once a week after wake-up, participants completed three different questionnaires: a sleep diary, an adjective list for psychophysical and motivational state, and a self-assessment questionnaire for sleep and awakening quality. Fifteen sport students executed the same protocol sleeping on the same pillow, but without stimulation. Subjective ratings of sleep and awakening quality, sleepiness and motivational state were significantly improved only in the intervention group, but did not impact their perceived physical state. In summary, eight weeks of auditory stimulation with binaural beats improved perceived sleep quality and the post-sleep state of athletes, whereas the effect on physical level is assumed to occur in a time-delayed fashion. It seems to be worthwhile - to further elaborate long-time effects and consequences on physical and mental performance.

12. J Occup Health. 2014;55(5):376-84.

Perceived fitness protects against stress-based mental health impairments among police officers who report good sleep.

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OBJECTIVES: This study examined a cognitive stress-moderation model that posits that the harmful effects of chronic stress are decreased in police officers who perceive high levels of physical fitness. It also determined whether the stress-buffering effect of perceived fitness is influenced by officers' self-reported sleep.

METHODS: A total of 460 police officers (n=116 females, n=344 males, mean age: M=40.7; SD=9.7) rated their physical fitness and completed a battery of self-report stress, mental health, and sleep questionnaires. Three-way analyses of covariance were performed to examine whether officers' self-reported mental health status depends on the interaction between stress, perceived fitness and sleep.

RESULTS: Highly stressed officers perceived lower mental health and fitness and were overrepresented in the group of poor sleepers. Officers with high fitness self-reports revealed increased mental health and reported good sleep. In contrast, poor sleepers scored lower on the mental health index. High stress was more closely related to low mental health among poor sleepers. Most importantly, perceived fitness revealed a stress-buffering effect, but only among officers who reported good sleep.

CONCLUSIONS: High perceived fitness and good sleep operate as stress resilience resources among police officers. The findings suggest that multimodal programs including stress management, sleep hygiene and fitness training are essential components of workplace health promotion in the police force.

14. J Sports Sci. 2014;32(2):172-4.

Sleep restriction and degraded reaction-time performance in Figaro solo sailing races.

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In solo offshore sailing races like those of the Solitaire du Figaro, sleep must be obtained in multiple short bouts to maintain competitive performance and safety. Little is known about the amount of sleep restriction experienced at sea and the effects that fatigue from sleep loss have on sailors' performance.

Therefore, we assessed sleep in sailors of yachts in the Figaro 2 Beneteau class during races and compared response times on a serial simple reaction-time test before and after races. Twelve men (professional sailors) recorded their sleep and measured their response times during one of the three single-handed races of 150, 300 and 350 nautical miles (nominally 24-50 h in duration). Total estimated sleep duration at sea indicated considerable sleep insufficiency. Response times were slower after races than before. The results suggest that professional

sailors incur severe sleep loss and demonstrate marked performance impairment when competing in one- to two-day solo sailing races. Competitive performance could be improved by actively managing sleep during solo offshore sailing races.

15. Med Sci Sports Exerc. 2014;46(5):1036-45.

Evidence of disturbed sleep and increased illness in overreached endurance athletes.

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PURPOSE: This study aimed to examine whether (i) objective markers of sleep quantity and quality are altered in endurance athletes experiencing overreaching in response to an overload training program and (ii) potential reduced sleep quality would be accompanied with a higher prevalence of upper respiratory tract infections in this population.

METHODS: Twenty-seven trained male triathletes were randomly assigned to either overload (n = 18) or normal (CTL, n = 9) training groups. Respective training programs included a 1-wk moderate training phase followed by a 3-wk period of overload or normal training, respectively, and then a subsequent 2-wk taper. Maximal aerobic power and oxygen uptake (VO2max) from incremental cycle ergometry were measured after each phase, whereas mood states and incidences of illness were determined from questionnaires. Sleep was monitored every night of the 6 wk using wristwatch actigraphy.

RESULTS: Of the 18 overload training group subjects, 9 were diagnosed as functionally overreached (F-OR) after the overload period, as based on declines in performance and VO2max with concomitant high perceived fatigue ($P < 0.05$), whereas the other 9 overload subjects showed no decline in performance (AF, $P > 0.05$). There was a significant time-group interaction for sleep duration (SD), sleep efficiency (SE), and immobile time (IT). Only the F-OR group demonstrated a decrease in these three parameters (-7.9% ± 6.7%, -1.6% ± 0.7%, and -7.6% ± 6.6% for SD, SE, and IT, respectively, $P < 0.05$), which was reversed during the subsequent taper phase. Higher prevalence of upper respiratory tract infections were also reported in F-OR (67%, 22%, and 11% incidence rate for F-OR, AF, and CTL, respectively).

CONCLUSION: This study confirms sleep disturbances and increased illness in endurance athletes who present with symptoms of F-OR during periods of high volume training.