

2019

## Should Athletes Receive Sleep Hygiene Education? A Systematic Literature Review

Ines L. Contreras  
*University of Central Florida*

 Part of the [Kinesiotherapy Commons](#)

Find similar works at: <https://stars.library.ucf.edu/honorsthesis>

University of Central Florida Libraries <http://library.ucf.edu>

This Open Access is brought to you for free and open access by the UCF Theses and Dissertations at STARS. It has been accepted for inclusion in Honors Undergraduate Theses by an authorized administrator of STARS. For more information, please contact [STARS@ucf.edu](mailto:STARS@ucf.edu).

---

### Recommended Citation

Contreras, Ines L., "Should Athletes Receive Sleep Hygiene Education? A Systematic Literature Review" (2019). *Honors Undergraduate Theses*. 477.  
<https://stars.library.ucf.edu/honorsthesis/477>



SHOULD ATHLETES RECEIVE SLEEP  
HYGIENE EDUCATION? A SYSTEMATIC  
LITERATURE REVIEW

by

INES L. CONTRERAS  
University of Central Florida 2019

A thesis submitted in fulfillment of the  
requirements for the Honors in the Major  
Program for the Burnett Honors College  
At the University of Central Florida  
Orlando, Florida

Spring Term  
2019

Thesis Chair: Thomas J Fisher, Ph.D., CSCS,  
LMHC

## ABSTRACT

Previous studies show the need to find a solution to improve the athlete's recovery and help overcome their sleep disorders. Sleep hygiene is a list of habits and recommendation that enhance sleep quality. Sleep hygiene education has been used in some research to fill the need of the athletes. Still, a lack of information exists on the development of sleep hygiene programs and related impacts. This thesis aims to perform a systematic review of the literature of scholarly journals articles from 2007 to 2018, focusing on the relationship between sleep hygiene education and athletes sleep quality and quantity. The investigation concluded with 16 qualifying articles. A synthesis of recommendations from all studies offered sleep hygiene suggestions for athletes; all the results are provided in table 12. The further overall conclusion of the selected articles settled that sleep hygiene is recommended for athletes, yet the methods and strategies are vague and not precise. A strong recommendation from this systematic literature review is the creation of a standardized list of sleep hygiene habits focused on athletes to improve their sleep quality and quantity.

## TABLE OF CONTENT

<i>I. INTRODUCTION:</i>	<i>1</i>
<i>II. PREVIOUS STUDIES:</i>	<i>5</i>
A. SLEEP DEPRIVATION EFFECTS ON ATHLETES	5
B. CAUSES OF SLEEP DEPRIVATION ON ATHLETES:	7
C. SLEEP TRACKING TECHNIQUES:	10
D. SLEEP VARIABLE MEASURES:	12
E. SLEEP HYGIENE AND TECHNIQUES:	13
<i>III. METHODS:</i>	<i>19</i>
<i>IV. RESULTS:</i>	<i>23</i>
<i>V. DISCUSSION:</i>	<i>32</i>
<i>VI. CONCLUSION:</i>	<i>38</i>
<i>VII. REFERENCE:</i>	<i>39</i>

## TABLE OF FIGURES

Table 1 (Sleep Variables Measures) .....	12
Table 2 .....	14
Table 3 .....	16
Table 4 .....	17
Table 5 (PRISMA flowchart).....	20
Table 6 (Results table 1) .....	24
Table 7 (Results table 2) .....	25
Table 8 (Results table 3) .....	26
Table 9 .....	27
Table 10 .....	27
Table 11 (Specific sleep hygiene recommendations found) .....	29
Table 12 (Sleep hygiene habits).....	31

## I. INTRODUCTION:

Sleep is considered a state of no or diminished movement and sensory responsiveness (H. K. Fullagar, Duffield, et al., 2015). "We spend about one-third of our life either sleeping or attempting to do so" (Aminoff, Boller, & Swaab, 2011). Still millions of Americans suffer from a severe sleep disorder. Copenhaver and Diamond (2017) introduced that sleep time is usually given up to compel all the activities of every day. Athletes are a considerable part of the population affected by these sleep disorders (Ford et al., 2014). Coaches and athletes consider a good sleep a critical factor for optimal performance (Venter, 2014). Around 1 in every 4 players experiences sleeping problems (Tuomilehto et al., 2017). In 2008, a research stated sleeping is a vital part of the stress-recovery balance in an athletes routine (Halsen, 2008).

Williamson (2000) studied a group of 39 subjects where half consumed 0.1% of alcohol, and the other half were deprived of 28 hours of sleep, later they were tested on their speed response, agility, vigilance, divided attention, and others. The researcher was able to correlate low levels of fatigue due to sleep deprivation could weaken reaction times, similar to or even higher than having a blood alcohol level over the legal limit for driving (Williamson, 2000).

A study with the Australian Football League reported that athletes have an average of 6.8 hours of sleep per night (Lastella, Roach, Halsen, & Sargent, 2015). Studies reported an average quantity of sleep in athletes between 6.5 to 8.0 hours (Lastella et al., 2015; Leeder, Glaister, Pizzoferro, Dawson, & Pedlar, 2012). This range is below the recommended hours of sleep by the National Sleep Foundation, which advocates 7 to 9 hours of sleep. According to Calder (2003), athletes should sleep between 9 to 10 hours. On a total of 23 studies, athletes ranked their

sleep <5 (scale 1 to 10), indicating that their sleep was not sufficient nor refreshing (Gupta, Morgan, & Gilchrist, 2017). Even when athletes obtain 7 to 8 hours of sleep for days, they still present significant changes in their sleep parameters compared to a control group, that could suggest low sleep quality (Leeder et al., 2012).

After a period of sleep extension, Stanford University men's varsity basketball players found to have a better performance. The results included better shooting accuracy, faster sprint time, and they found basketball players have a better mood and less fatigue (Mah, Mah, Kezirian, & Dement, 2011). In 2018, a research showed a positive correlation with longer sleep duration to finishing places in a multiday event, the first 2 teams had an average of 8:02 hours compared to the bottom teams which average a sleep duration of 7:01 hours (Juliff, Halson, Hebert, Forsyth, & Peiffer, 2018). In swimmers, an increase sleep time to 10 hours of sleep for 6 to 7 weeks follow an improvement in turn time and reaction time (Mah, Mah, & Dement, 2008).

There are multiple strategies recommended in order to recover from sleep debt in athletes. Some are sleep extension (including daylight naps), post-exercise recovery strategies (i.e., meditating, muscle relaxation) and sleep hygiene. This study will only aim to focus on sleep hygiene techniques. Sleep hygiene is the easiest to administer since the participants can self-report and administer the techniques without any additional help. The sleep homeostatic and the circadian rhythm can be overridden by behavioral factors, in either a beneficial way or with a bad outcome (Bjorvatn & Pallesen, 2009).

Many alterations in the environment could affect athletes; examples of these variants could be the traveling for competitions, jet-lag, the training time, and caffeine consumption (H. K. Fullagar, Duffield, et al., 2015). According to Lack and Wright (2007), the distress in an

athlete's life pattern can cause a uncontrolled homeostatic pressure and emotional regulation, affecting the circulating levels of melatonin and core temperature, all causing an impediment on sleep onset. Researches tend to agree that coaches, trainers, and mentors are not giving enough importance to the impact of sleep deprivation (Gupta et al., 2017).

A systematic literature review in 2018 focused on relating the efficacy of sleep interventions on athletes; the study highlighted that athletes sleep disturbance came at two-time points (Bonnar, Bartel, Kakoschke, & Lang, 2018). One of them was during the regular training period, when the alteration of the athletes' sleep was due to chronic sleep complaints, a response to heavy training workloads, and poor sleep hygiene. The other time period is competition season where athletes present sleep disturbances due to pre-competition anxiety and disruption to usual sleep routines.

There is a limited understanding of the effects of sleep on athletic performance because there is reduced availability of participants who qualify to enter athlete-based studies (H. H. K. Fullagar, Duffield, et al., 2015). As well as the variations that could affect sleep deviate per case, due to each person being and reacting differently to a stimulus. Some of the variation include but are not limited to sport, type of athlete, and training plan. According to Bonnar and colleagues (2018), 2 methodological issues reduce the relevance of the multiple findings in sleep studies. These issues included that sleep studies based their research on populations who do not qualify as elite/professional athletes, or that the recovery outcome or performance results were not measured in tandem with sleep. The study also reported that many of the sleep studies do not focus on the real-life scenarios for athletes since they are based on extreme sleep deprivation instead of partial deprivation (Bonnar et al., 2018).



Many athletes are seeking to solve their sleeping issue. Prior other literature reviews have shown that there is insufficient knowledge regarding guidance on how to treat sleep disorder in athletes (H. H. K. Fullagar, Duffield, et al., 2015). Tuomilehto et al. (2017) found that 36% of their study population of athletes took sleep medication at least 1 night per week. Melatonin is a natural option that could be administered to athletes. Melatonin can be found as a supplement, or it can also be found naturally in some foods (Nédélec et al., 2015). The abuse of melatonin can lead to hypothermic and hypnotic responses, leading to impairment in performance (Atkinson, Drust, Reilly, & Waterhouse, 2003). These supplements are not banned by the World Anti-Doping Agency, since there is not enough data on them. However, research studies in this area have not completely concluded if melatonin impairs performance.

Different researchers have been trying to find a sleep recovery strategy that aims the athlete's issues. Based on the lack of current information and clarity regarding the sleep needs of athletes, this thesis aims to perform a systematic review of the literature of scholarly journal articles from 2007 to 2018, in order to focus the relationship of sleep hygiene education and athletes sleep quality and quantity.

## II. PREVIOUS STUDIES:

Even though this is a new field of investigation, the term sleep hygiene has been used since 1997 (Hauri, 1977). However, the field of sports has primarily ignored this topic. The following subheadings will organize the prior related studies: Sleep deprivation effects, causes of sleep deprivation on athletes, sleep tracking techniques, sleep hygiene, and sleep hygiene techniques.

### A. SLEEP DEPRIVATION EFFECTS ON ATHLETES

Halsen (2013), research recognized that nights of sleep is the best recovery an athlete could get, not only physiologically but psychological as well. There are several theories of the function of sleep, according to Frank and Benington (2006). One of the hypotheses is a neurometabolic theory which implies that sleep helps in the healing of the nervous and metabolic cost of the waking state. Another theory is the recovery effects on the endocrine system and the immune system. The research also has a theory which imposes that sleep has an essential role in cognitive development, especially on the synaptic plasticity, learning and memory(Frank & Benington, 2006). Studies like the one conducted by Stickgold (2005), stated that there is an improvement in the motor task after a night of sleep, compared to a group of people who had a period of being awake.

Fullagar (2015) described the meaning of sleep in athletes in respects to memory consolidation, and motor learning is key to their performance. Elite athletes need an ongoing adaptation on their motor learning and cognitive adaptation for theirs to performance (Mahoney & Avenier, 1977). Athletes need an optimal brain state for them to process the training information (Mahoney & Avenier, 1977). O'Donnell and Driller (2017) mention that the

emphasis of the contribution to the psychophysiological recovery of the elite athletes by sleep is neglected. Kellmann (2010) believes that a sign of overtraining syndrome is disturbed sleep.

Many studies have shown that the impact of sleep debt and sleep loss have a negative impact on athletes. Competitive athletes are at higher risk of presenting performance issues due to sleep quantity and quality because they are under higher demands which expose the harmful effects of sub-optimal sleep (Van Ryswyk et al., 2017). Fullagar et al. (2015) provided a review of all the current evidence that could relate sleep to recovery, and the results are worrying. Even though, the amount of study in the area is low; a conclusion was drawn. The study stated that low levels of sleep led athletes to reduced abilities to understand and follow instructions, increased errors in decision making, lower reaction times, and problems with memory retention and recall (H. H. K. Fullagar, Duffield, et al., 2015).

A previous study established that the highest impact of sleep deprivation on athletes was shown on their sport-specific skill execution, their muscular and anaerobic power, and their resistance (H. H. K. Fullagar, Duffield, et al., 2015). As well, the impact of sleep deprivation would be seen in their cognitive reactions such as in their reaction time, memory, decision making, fine motor movements. In contrast, their aerobic output and maximal measurement of strength do not seem to show a significant impact after a lousy night of sleep (H. H. K. Fullagar, Duffield, et al., 2015). According to Bonnar et al. (2018) sport-specific skills execution, muscular and aerobic power, and submaximal sustained exercise bouts are debilitated when there is partial sleep deprivation. Also, injury rates will increase in an athlete after a night of fewer than 6 hours of sleep (Luke et al., 2011).

Harada et al (2016), presented a leaflet that included an explanation that a late bedtime will lessen the production of growth hormone for athletes. Growth hormone is required to repair the damage of muscle and small vessels that might have been injured during training; a late sleep onset impairs this adjustment process (Harada et al., 2016). This hormone stimulates protein synthesis and has an impact on muscle and bone repair, and it is released from the pituitary gland during the night (Davenne, 2009). Another aspect that is affected by sleep loss is the athlete's mood which can negatively affect their performance (Lane, 2000; Pilcher & Huffcutt, 1996). Yoo, Gujar, Hu, Jolesz, & Walker (2007), proposed a hypothesis to explain the relationship between a bad mood and sleep deprivation is the reduced connectivity between the prefrontal cortex and the amygdala with increased activity of the amygdala. Having a poor mood has been related to being a sign of over-training and over-reaching (Coutts, Reaburn, Piva, & Rowsell, 2007).

The majority of the studies that show the effects of sleep loss on athletes' only use and recreate extreme cases of sleep deficit (Bonnar et al., 2018). Still, many studies lack the representation of real-life encounters which athletes pursue in their career (H. H. K. Fullagar, Skorski, et al., 2015). Hence; further research needs to be done to study real-life scenarios which athletes encounter.

#### **B. CAUSES OF SLEEP DEPRIVATION ON ATHLETES:**

Elite athletes have many constraints non-professional athletes will not endure. These are the high levels of training, travels, a tight competition season schedule, high-intensity training/activities before bedtime, games at night, napping during the day, use of enhancers such as caffeine, and others (American Sleep Disorders Association, 1997). Other conditions that

could affect the disruption of sleep are the raised temperature after exercising (Nédélec et al., 2015), the light and noise disruption (O'Donnell & Driller, 2017), the psychological stress (H. H. K. Fullagar, Duffield, et al., 2015) and the elevated muscle tension and distress after a training session (Halsen, 2014)

Fullagar et al. (2015) compiled all the situations that could affect a team-sport athlete into 3 categories: team-sport matches played at night, sleep and travel fatigue, and sleep and congested competition schedules.

As Fullagar et al. (2015) highlighted game time are often established by television programs, usually ending in night games . Meyer and colleagues (2014) presented that at the European Soccer Tournaments games are usually scheduled at night, reporting in less sleep on their players . Moreover, in the Spanish La Liga, some games will not even start until 10:00 PM delaying the players' bedtime (Nédélec et al., 2013). Besides, it has to consider that players will have to attend to other commitments after the game such as social functions, press conferences and recovery practices (Nédélec et al., 2013). In 2014, a study pointed out that on game nights the athlete's sleep duration was less compared to other nights (Eagles, Mclellan, Hing, Carloss, & Lovell, 2014). Physical activity increases arousal and is considered that any exercise at later hours of the day will result in more sleep disturbances compared to training during daylight (Meyer et al., 2014). Another study suggested that the sleep quality of judo athletes was affected after performing a maximal aerobic exercise during the evening, the investigation had a result of more awakenings and a higher sleep-onset latency (Souissi et al., 2013). However, an sleep onset deferred can also be produced by cognitive fatigue and mental stimulation (Stickgold, 2005).

In 2014, elite Australian soccer players reported a significant reduction of their sleep duration and quality on nights before an away game (Fowler et al., 2017). Fullagar et al. (2015) describe travel fatigue to be linked to the frequency and the distance traveled during the season. Samuels (2012), stated that there is a difference between jet-lag fatigue and travel-induced fatigue, jet-lag consist of time-zone changes and its effects. The effects of travel-induce fatigue can include difficulty in sleep onset, acute fatigue, a decline in mood, dehydration, and loss of motivation(Samuels, 2012).

Athletes are asked to maintain a heavy loaded training/games schedule. This is visible in Major League Baseball players; their games are played every 2 days, all across the country, affecting their circadian rhythm and many others aspects that could prevent an optimal sleep (Winter, Hammond, Green, Zhang, & Bliwise, 2009). There is a potential that a high physical workload might influence the quality and quantity of sleep (H. H. K. Fullagar, Duffield, et al., 2015). Besides, since 1997 there has been mentioning that sleep can be affected by high training volumes (Taylor, Rogers, & Driver, 1997). The stress-recovery balance is affected by excessive training loads, resulting in injury and reduce performance (Kellmann, 2010).

Compared to other recovery practices (i.e., electrical stimulation, cold water immersion, compression garments) sleep is not tight to the compliance of the athlete (Nédélec et al., 2015). Cole (2005), describe the sleep/wake process as a “flip-flop switch” that once the switch has been established, the process will follow transition instead of resisting it. Nonetheless, the transitional process from awake to sleep and opposite where the “switch” is partially active for both ways tends to more unstable, and the more active state (sleep or wake) will turn down the

opposite. Using practices that players can self-administer, such as sleep hygiene, can help to ease the unstable process and allows a smoother system to wake up/fall asleep (Cole, 2005).

### C. SLEEP TRACKING TECHNIQUES:

Halsen (2014), advocated that athletes should use wristwatch actigraphy or sleep diaries to track their sleeping patterns during the season. Sleep can be tracked in different ways, some can be objective (polysomnography and actigraphy), and others can be subjective (i.e., questionnaires).

The best and cheapest way to track sleep is by using actigraphy devices that monitor the movement of athletes during the night. Some devices are even able to measure heart rate and light exposure of the athlete. The use of actigraphy in the healthy adult population has been valid and reliable (Sadeh, 2011). The benefits of using actigraphy include that the patient can use it on their home environment, and is less intrusive compared to polysomnography (PSG) (Dennis, Dawson, Heasman, Rogalski, & Robey, 2016; O'Donnell & Driller, 2017). The objective measurements are more intrusive and expensive than a subjective approach, and they usually need to be coupled with specialized expertise which makes it even harder to use in a study (M. W. Driller, Mah, & Halsen, 2018). As well, the use of objective measurements can be time-consuming when a large number of athletes is being assessed.

Another way to track sleep is with a subjective approach using self-reports, such as journals and questionnaires. One of the questionnaires most used is The Pittsburgh Sleep Quality Index (PSQI); has become a standardized measure to analyze sleep quality. The PSQI has been used since 1989 when the questionnaire was designed (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The index comprehends of a 19 self-rated questionnaire to evaluate the subjective

sleep quality for the past month. The PSQI classifies the question into 7 subscale measures: sleep duration, subjective sleep quality, habitual sleep efficiency, sleep latency, use of sleep medication, daytime dysfunction and sleep disturbances. The score of the subscale adds to a total of 21 points, the higher the score is the worst sleep quality, 5 being the cutoff score. Buysse et al. (1989) stated that it has a specificity of 86.5% to identify sleep disorder.

The Morningness-Eveningness Questionnaire (MEQ) by Horne and Ostberg (1976) includes 19 questions that allow measuring the aspect morningness. The questionnaire includes subscales such as preferred time for performing activities (that will require physical and mental alertness), time feeling sleepy, and sleep habits. The score range goes from 16 to 86 points, with normative values of 16 to 30 “definitely evening type,” 31 to 41 “moderate evening type,” 42 to 58 “neither type,” 56 to 69 “moderately morning type,” 70 to 86 “definitely morning type.”

The Profile of mood states (POMS) is used to measure the mood states in athletes (Van Ryswyk et al., 2017). POMS was designed in 1971, and it consists of 65 questions with 6 subscales (McNair, Lorr, Droppleman, & Educational and Industrial Testing Service, 1971). The questionnaire ranks the patients into 6 moods being tension, depression, anger, vigor, fatigue, and confusion. Due to its long structure, POMS is usually modified to smaller version adapted to the researchers' goals.

The Epworth Sleepiness Scale (ESS) is another self-reported questionnaire that allows the rank of daytime sleepiness in patients (Mastin, Bryson, & Corwyn, 2006). ESS was designed in 1991, and it includes 8 questions that add to a score scale of 0 to 8 if the final score adds up to higher than 10 it suggests significant daytime sleepiness (Johns, 1991).



Lastly, sleep diaries are an option to track self-reported measurement. They are valid and inexpensive and seems to show a correlation with actigraphy (Kawada, 2008). A sleep diary can be modified and used to the convenience of the research; the journal could be used to track estimations of bedtime, sleep quality, daytime functioning, rise time, and other measurements.

#### D. SLEEP VARIABLE MEASURES:

Sleep tracking devices and questionnaires are used to measure and calculate sleep variables. Here a modified table (table 1) adapted from O'Donnell and Driller (2017) and Driller, McQuillan and O'Donnell (2016) which includes the definition and measurement of the most common sleep indices.

*Table 1 (Sleep Variables Measures)*

Sleep Indices	Units	Description
Total Sleep Time (TST)	Minutes	Time spent asleep
Sleep Efficiency (SE)	Percentage (%)	Total time in bed divided by total sleep time
Total Time in bed (TTB)	Minutes	Total time spent in bed (does not means sleeping)
Sleep Latency (SL)	Minutes	Time taken to fall asleep
Wake Episode per Night (WE)	Number count	Total numbers of awakening per night
Sleep Onset Variance (SOV)	Minutes	Variation in sleep onset time (variation in sleep latency)
Wake Variance (WV)	Minutes	Deviation in wake time
Wake Episode Duration (WED)	Minutes	Mean wake episode duration
Sleep Onset Time (SOT)	Time of day (hh:mm /P.M.)	The exact time when fell asleep
Wake Time (WT)	Time of day (hh:mm /A.M.)	The exact time when woken in the morning

Samuels (2008) mentioned that 3 main factors would compromise the recuperative outcome of sleep. These 3 factors are Sleep quality (or Sleep efficiency), Total Sleep Time (TST) and the time of sleep (phase in the circadian rhythm timing). Sleep Efficiency can be very uncertain because even when the calculation of the percentage (TBT/TST) gives a high number, the person can still report a low sleep quality. Sleep quality does not have a defined definition. Still, sleep quality could be referred to as personal satisfaction (Krystal & Edinger, 2008). There is a window that can be the best and smoothest time to go to sleep, and this period is the time when the secretion of melatonin is high (Borbély, 1982). Even when the athletes are under extreme conditions that violate the basics of sleep hygiene the circadian rhythm impact is still apparent (Van Maanen et al., 2015).

#### E. SLEEP HYGIENE AND TECHNIQUES:

Doctor Hauri (1977) was the first one to use the term "sleep hygiene" He used the term to refer to all recommendations he indicated to his patients who presented insomnia. Hauri (1977), used this term to discuss the effects caused by the use of caffeine, alcohol, and exercise. The term was defined as a set of environmental and behavioral recommendations to enhance sleep quality (Hauri, 1977). Sleep hygiene is also known as sleep habits (Mastin et al., 2006). The American Sleep Disorder Association (1990, p. 73) described inadequate sleep hygiene as a "Sleep disorder due to the performance of daily living activities that are inconsistent with the maintenance of good quality sleep and full daytime alertness".

Sleep disturbances are issued at the beginning of every human life; new parents are being addressed in many ways on how to "sleep train" their babies. Dr. Copenhaver and Dr. Diamond (2017) addressed on the Pediatric Annals journal that the American Academy of Pediatrics has a

guide for children from 6 months to 6 years to discuss the introduction of sleep hygiene with parents, however, there is a lack on recommendations of how to continue the habits is later years, especially in the adolescents years.

Sleep hygiene incorporates numerous recommendations that are established on lifestyle aspects and behaviors, but it also includes environmental factors (O'Donnell & Driller, 2017). The American Academy of Sleep Medicine (2001) included as sleep hygiene all practices and conditions that encourage uninterrupted and sufficient sleep. The strategies for sleep hygiene have evolved with time and research on the behavioral factors that worsen or improve sleep (Nédélec et al., 2015). Hauri posted the original list of strategies for sleep hygiene in 1977; he later posted an updated list on 1991(Hauri, 1977, 1991). These recommendations are:

*Table 2*

List of Sleep Hygiene Recommendations by Hauri (1991)
<ol style="list-style-type: none"> <li>1. Curtail time in bed.</li> <li>2. Never try to sleep.</li> <li>3. Eliminate the bedroom clock.</li> <li>4. Exercise in the late afternoon or early evening.</li> <li>5. Avoid coffee, alcohol, and nicotine.</li> <li>6. Regularize the bedtime.</li> <li>7. Eat a light bedtime snack.</li> <li>8. Explore napping.</li> <li>9. Monitor use of PRN hypnotics.</li> </ol>

Stepanski and Wyatt (2003) analyzed the list and gave one interpretation for the rule 2 “Never try to sleep” they described that the best way to interpret is not to make patients diagnosed with insomnia go to bed if they are not sleepy. In other words, not make the patient force their way to sleep. The researchers also interpreted the rule 3 to eliminate any distraction or

arousal during the night that could develop undesired cognitive activity (Stepanski & Wyatt, 2003).

Sleep hygiene strategies have been adapted to more limited instructions (Stepanski & Wyatt, 2003). The recommendations now includes tactics such as appropriate napping, light therapy, consistent sleep pattern, optimal temperatures, limiting enhancing products (e.g., caffeine and alcohols), keeping a regular sleep-wake cycle (Copenhaver & Diamond, 2017; Fullagar, Skorski, Duffield, & Meyer, 2016; Nédélec et al., 2015). Other advice includes in sleep hygiene are reducing the stress and arousal hours before sleep (Stepanski & Wyatt, 2003). The Association of American Sleep Disorders (1997) mentioned the following sleep hygiene recommendations: avoidance of consumption of caffeine or alcohol near bedtime, setting a wakeup time and bedtime, avoiding high-intensity exercise or activities that need high levels of concentration before bedtime, avoid daytime napping.

The International Classification of Sleep Disorders (ICSD)(American Sleep Disorders Association, 1990)added a diagnosis category as “Inadequate Sleep Hygiene” (1990). The behaviors presented by patients with poor sleep hygiene were described as the following.

Table 3

ICSD definition of Inadequate sleep hygiene
<ol style="list-style-type: none"> <li>1. Daytime napping at least two times each week.</li> <li>2. Variable wake-up times or bedtime.</li> <li>3. Frequent periods (two to three times per week) of extended amounts of time spent in bed.</li> <li>4. Routine use of products containing alcohol, tobacco, or caffeine in the period preceding bedtime.</li> <li>5. Scheduling exercise too close to bedtime.</li> <li>6. Engaging in exciting or emotionally upsetting activities too close to bedtime.</li> <li>7. Frequent use of the bed for non-sleep-related activities (e.g. television watching, reading, studying, etc).</li> <li>8. Sleeping on an uncomfortable bed (poor mattress, inadequate blanket, etc).</li> <li>9. Allowing the bedroom to be too bright, too stuffy, too cluttered, too hot, too cold, or in some way not conducive to sleep.</li> <li>10. Performing activities demanding high levels of concentration shortly before bed.</li> <li>11. Allowing mental activities, such as thinking, planning, reminiscing, etc. to occur in bed.</li> </ol>

Mastin, Bryson and Corwyn (2006), created with an assessment of Sleep Hygiene called the Sleep Hygiene Index; it includes 13 questions to indicate if the patient presents inadequate sleep hygiene. The questionnaire asks the patient to rank on how frequent they occupy in precise behaviors (never, rarely, sometimes, frequently, always). The total items are score added to obtain a global assessment of sleep hygiene; a high score is related to a lack of inadequate sleep hygiene. The following table includes the sleep hygiene index (Mastin et al., 2006).

Table 4

Sleep Hygiene Index Items:
<ol style="list-style-type: none"> <li>1. I take daytime naps lasting two or more hours.</li> <li>2. I go to bed at different times from day to day.</li> <li>3. I get out of bed at different times from day to day.</li> <li>4. I stay in bed longer than I should two or three times a week.</li> <li>5. I exercise to the point of sweating within 1h of going to bed.</li> <li>6. I use alcohol, tobacco, or caffeine within 4h of going to bed or after going to bed.</li> <li>7. I do something that may wake me up before bedtime (i.e. play video games, use the internet or clean).</li> <li>8. I go to bed feeling stressed, angry, upset, or nervous.</li> <li>9. I use my bed for things other than sleeping or sex (i.e. watch television, read, eat, or study).</li> <li>10. I Sleep on an uncomfortable bed (i.e. poor mattress or pillow, too much or not enough blankets).</li> <li>11. I sleep in an uncomfortable bedroom (i.e. too bright, too stuffy, too hot, too cold, or too noisy).</li> <li>12. I do important work before bedtime (i.e. pay bills, schedule, or study).</li> <li>13. I think, plan, or worry when I am in a bed.</li> </ol>

Caia et al.(2018) noted that the most common way to present sleep hygiene is via an educational session, which is inexpensive and simple with a very easy implementation. In an educational session, patients are thought about healthy sleep habits, and they are prompted to follow a set of recommendations to enhance their sleep (Zarcone, 2003). The recommendation is commonly used since it does not require a professional and, they can be self-enforced it (Irish, Kline, Gunn, Buysse, & Hall, 2015). Bonnar et al. (2018), highlighted that implementing these techniques does not require any special equipment or training. Therefore, the recommendations are easy to apply when athletes are away for competition or at home.

A sleep hygiene education is a first-line intervention to patients who present sleep problems or want to improve their sleep but do not necessarily qualify for a clinical treatment (Irish et al., 2015). Another reason to use sleep hygiene education is that its adherence is high and increases over time compared to other treatments according to Berger and associates (2002).

Stepanski and Wyatt (2003), found a correlation which states that the use of sleep hygiene education improves sleep quantity and quality. O'Donnell and Driller (2017), mentioned varying levels of success across sleep hygiene studies on populations other than athletes. After a week with daily 50-minute sleep hygiene course, a group of 58 adolescent students showed a significant decrease in their sleep latency (De Sousa, Araújo, & De Azevedo, 2007). In a study of 391 employees of an information technology company, results were obtained 4 weeks after a 50-minute of sleep hygiene, and it showed that their daytime sleepiness was reduced (Kakinuma et al., 2010). In university students, sleep hygiene education seems to improve sleep quality and sleep onset latency (Stepanski & Wyatt, 2003). Maintaining similar sleep-wake times helped to synchronize the circadian rhythm, resulting in a better sleep quantity and quality.

When considering athletes, the data is still uncertain due to interplay interactions between sleep hygiene, psychological parameters, and the recovery of exercise (H. H. K. Fullagar, Duffield, et al., 2015). The usefulness of sleep hygiene principles is worth investigating before educating athletes in sleep hygiene. It is critical to consider the importance of sleep in their recovery and performance. Preceding data indicated that sleep hygiene practices improved sleep quality and show some reduction in fatigues and perceived soreness in elite tennis players (Duffield, Murphy, Kellett, & Reid, 2014).

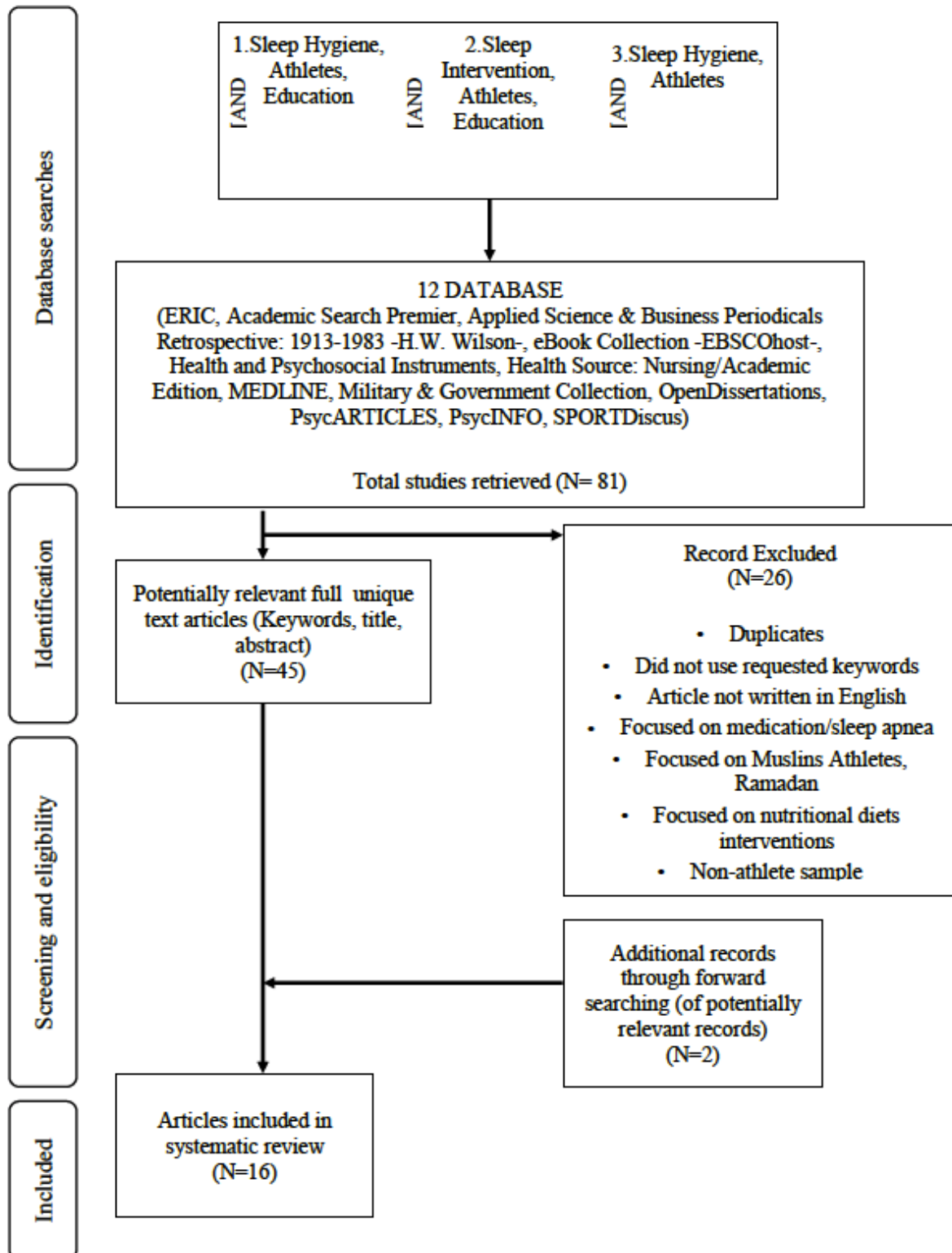
### III. METHODS:

The strategy for this research included the use of 12 databases: ERIC, Academic Search Premier, Applied Science & Business Periodicals Retrospective: 1913-1983 -H.W. Wilson-, eBook Collection -EBSCOhost-, Health and Psychosocial Instruments, Health Source: Nursing/Academic Edition, MEDLINE, Military & Government Collection, OpenDissertations, PsycARTICLES, PsycINFO, and SPORTDiscus. The 12 databases were used on 3 different searches in February 2018. The articles selected ranged from the 2007 to 2018 publication period. A reference librarian recommended the suggested databases as well as keywords related to each search.

There is 2 other literature reviews similar to this study : Bonnar et al. (2018) and Gupta et al. (2017). Both of them lead a systematic review using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols), based on their flow chart and the original PRIMA proposed by the PRISMA-P group et al. (2015) a final chart (table 5) was submitted and used to hold the systematic review process for this thesis.



Table 5 (PRISMA flowchart)



To be considered for this systematic literature review, each article went through a preselection process. First, the title and abstract were analyzed. If the article did not seem consistent with the topic of sleep hygiene; the study was eliminated. Sleep hygiene is an essential part of the investigation, hence, to be included the articles needed to implement a sleep hygiene education program to enhance athletes sleep quality. All the articles not written in English and duplicates were discarded from the search. No exclusion was made due to age range in their population. Literature reviews that included sleep hygiene implementation on athletes were included as well.

On the first search, the keywords used were: “sleep hygiene,” “athletes,” AND “education.” The initial database search suggested 15 articles that met the selection criteria. After some elimination of duplicates and unrelated articles, the total number was 6.

On the second search, the following keywords were used: “sleep intervention,” “athletes,” AND “education.” The investigation suggested 24 articles that met the selection criteria. Still, following further examination, again eliminating duplicates and unrelated articles, the final number of articles number was only 4.

The third inquiry used the keywords: “sleep hygiene” AND “athletes.” The search initially produced 42 articles. Though discarding duplicates from the 2 previous searches, and unwanted material the final number of considered publication was 7.

The given analysis resulted in a total of 16 articles. Each of the articles was read and analyzed according to their sleep measurement. Additional studies were analyzed if they were cited in more than 4 of the selected articles, even when they were older than our time frame. The information was considered pertinent if it was used as based information for one of the selected

articles. This review was based on 3 searches to show the readers that even with different keywords, there is not enough information to investigate the sleep needs of athletes.

Many articles had to be eliminated from this literature review because they were not directly related to the topic. A typical field that was found in many articles using the term "sleep hygiene in athletes" was focused upon Muslim athletes and their training schedule during Ramadan. These studies were excluded because their research was based on an extreme environment and unique requirements. Muslim students fast from dawn until the sunset for the total length of Ramadan. As well according to Fowlers and colleagues (2017), most Muslims athletes practice salat alfajr (dawn prayer) where they are required to wake at dawn to pray. These sleep interruptions and circadian rhythm changes during their fasting periods will give a different result compared to athletes who will not follow these trends.

Another frequent topic that was omitted from the review were research based on nutritional strategies. These studies based their hypothesis on how the nutritional intake of athletes could affect their performance and recovery process (including sleep). The search that resulted in higher studies and articles nutritionally related was the second inquiry, were 3 articles had to be excluded due to being based on carbohydrate intakes and its effect on sleep and athlete's performance. For example, Killer, Svendsen, Jeukendrup, and Gleeson (2017) aimed to show the effects of moderate vs. high carbohydrate intervention on sleep parameters, mood state and exercise performance during intensified training. They came with results that the total sleep time was higher in the control group vs the group with a high carbohydrate diet. Still, they recommended that athletes should implement sleep strategies such as sleep hygiene in order to optimize their sleep (Killer et al., 2017).

#### IV. RESULTS:

The information obtained from the 16 articles analyzed in the review is presented in a modified version of a table used in the systematic review by Bonnar et al. (2018). The articles were reviewed on their methods (Intervention Method, Sleep hygiene Specific Recommendation, Time Period, Sleep Tracking system) the population (total number, gender percentage, type of sport/athlete) and their results (Sleep measurements, and outcomes). The literature reviews were included in the review adding their conclusion to the results. The following tables 6, 7 and 8 include all the articles and the analysis made for this thesis.

Table 6 (Results table 1)

Study	Population		Methods		Results	
	N	Gender %	Sport/ Athletes	Intervention Methods	Sleep Hygiene Recommendation (yes/no)	Time period
Caia, J., Scott, T. J., Halson, S. L., & Kelly, V. G. (2018)	24	Males	Professional Rugby League	The 12 athletes that presented the shortest average on sleep duration received a sleep hygiene education.	No	Four weeks period. (time: 2-week Baseline, Sleep Hygiene week-1, Sleep Hygiene Week 2), a follow-up after a month.
Bonmar, D., Bartel, K., Kakoschke, N., & Lang, C. (2018)	N/A	N/A	N/A	Sleep extension and napping. Sleep hygiene, post-exercise recovery strategies to improve nocturnal sleep	N/A	N/A
Bird, S. P. (2013).	N/A	N/A	N/A	N/A	Yes	N/A
Copenhaver, E. A., & Diamond, A. B. (2017).	N/A	N/A	Young Athletes	N/A	Yes	N/A
Driller, M. W., Mah, C. D., & Halson, S. L. (2018).	282 males and 282 564 females	242 athletes and 322 non athletes	Development of an athlete-specific sleep questionnaire ( Athlete Sleep Behavior Questionnaire)	N/A	N/A	N/A
Fullagar, H., Duffield, R., Skorski, S., Coutts, A. J., Julian, R., & Meyer, T. (2015).	N/A	N/A	Team-Sport Athletes	N/A	Yes	N/A
Fullagar, H., Skorski, S., Duffield, R., & Meyer, T. (2016)	20	Males	Highly-trained amateur soccer players	Presented with sleep hygiene strategies to follow	Yes	2 weeks

Table 7 (Results table 2)

Study	Population		Methods		Results	
	N	Gender %	Sport/ Athletes	Intervention Methods	Sleep Hygiene Specific Recommendation (yes/no)	Time period
Harada, T., Wada, K., Tsuiji, F., Krejci, M., Kawada, T., Noji, T., Takeuchi, H. (2015).	84	Males	University Football Club	Presented with a leaflet	Yes	1 month
Harris, A., Gundersen, H., Andreasen, P., Bjorvatn, B., & Pallesen, S. (2015).	Intervention group (14 females and 22 males) Control group (16 females and 24 males)		High School Athletes. Practicing various sports.	Restriction use of electronic media after 22:00	No	1 month
Hoshikawa, M., Uchida, S., & Hirano, Y. (2018).	449 males and 368 females		Athletes from 17th Asian Games Incheon 2014	N/A	N/A	N/A
Knufinke, M., Nieuwenhuys, A., Geurts, S. A., Coenen, A. M., & Kompiers, M. A. (2017)	56 females and 42 males		Netherlands Olympic Committee and Netherlands Sport Federation	N/A	No	One month
<p>Questionnaire (Diurnal-type Scale, questions on sleep habits and meal habits and General Health Questionnaire (GHQ))</p> <p>Sleep quality was better than before the intervention; the frequency to be irritated was lower (3 months after the intervention). Improvement value in soccer was significantly high.</p> <p>Questionnaires (MEQ, Positive and Negative Affect Scale), Sleep Diaries and Athletic performance test</p> <p>No significant difference in the sleep patterns comparing the intervention group vs. control group</p> <p>For PSQI: mean TTB 7h and 29 min, more than half of athletes, have napping habits of once or more per week and naps of 30-60 min. 11.1% of male and 13.9% of women presented SE lower than 85%. SLEEP CHECKLIST: for both sexes, less than 20% replied "I already do so" to the item "avoiding the use of electronic devices just before bedtime" and "not thinking about troubles in bed."</p> <p>MULTIPLE LOGISTIC REGRESSION ANALYSIS: for males time in bed, depressive mood and the hygiene-factor "not thinking about troubles.. were significantly associated with poor sleep quality. For females getting up time, the depressive mood the hygiene-factors "not thinking about troubles in bed" and "preventing an irregular getting up time (within 2h)" were significantly correlated with poor sleep quality.</p> <p>Subclinical questionnaires (PSQI, HSDQ, GSQS, GVA, KSS), sleep diaries (Consensus Sleep Diary) and sleep hygiene Index</p> <p>A significant correlation between sleep hygiene, sleep quantity and quality indicated at the general level. The study indicated adequate overall sleep hygiene in elite athletes, while certain daytime behaviors such as psychological strain, pre-sleep activities, irregular bed-times, and taking late-evening consumptions can be improved.</p>						

Table 8 (Results table 3)

Study	Population		Methods			Results		
	N	Gender %	Sport/ Athletes	Intervention Methods	Sleep Hygiene Specific Recommendat ion (yes/no)		Time period	Sleep Tracking System
Maanen, A. V., Roest, B., Moen, M., Oort, F., Vergouwen, P., Paul, I., ... Smits, M. (2015)	10 (divide 9 mens d into 2 and 1 groups) female	9 mens 5h resting	500km multiday relay event (5h running, 5h resting)	Extreme violation of sleep hygiene	No	Event period	Actigraph (Vivago Ultrawatch)	TST was on average 43 min longer when sleep was during favorable sleep time. Circadian rhythm still apparent even under extreme circumstances
Nédélec, M., Hanson, S., Delecroix, B., Abaidia, A., Almaïdi, S., & Dupont, G. (2015)	N/A	N/A	N/A	N/A	Yes	N/A	Literature Review	Athletes recoveries strategies and sleep hygiene should be adapted to each constraint. Sleep hygiene that supports natural environmental light-dark cycle and prevents cycle disruption are available to manage the impact of light on sleep.
O'Donnell, S., & Driller M. (2017)	26 Females	N/A	Elite netball athletes	One 50min session of sleep hygiene education. Athletes were reminded daily after it	Yes	Over 2 weeks (1 week PRE, 1 week POST)	Actigraph (Readband)	TST ↑ (22.3±39.9 min), WV ↓ (21.2± 34.6min), WED ↓ (3.3±6.6 min), SE ↑ (2.6±5.7min)
Ryswyk, E. V., Weeks, R., Bandick, L., O'Keefe, M., Vakulin, A., Catcheside, P., ... Antic, N. A. (2016)	26 Males	Australian Football League	2 one hour education session one on week 1 and one mid- programm	No	No	6 weeks program	Actigraph (Phillip Respruonics), Sleep Diaries (time in bed, daytime naps, intake of caffeine and alcohol, and time at which they turned the lights out for sleep)	A significant increase in TST and SE as measured via sleep diaries, but no considerable difference in TST using actigraphy. A significant decrease in fatigue and an increase in vigor, but no changes in perceived stress or training stress, and both levels of stress were in the normal range.
Tuomilehto, H., Vuorinen, V., Penttilä, E., Kivimäki, M., Vuoremaa, M., Venöjärvi, M., ... Pihlajamäki, J. (2016)	107 Males	Professional ice hockey	Sleep counseling	No	No	One year	Questionnaire (Basic Nordic Sleep questionnaire with amendments related to athletic performance)	83% of the athletes reported having benefited from the counseling. At the follow up the average sleep quality was rated at 8.1. Significant improvement in sleep quality

The Questionnaires used in all the studies are presented in the following figure 2 which also includes the number of articles that used the questionnaire. The most used ones were ESS, MEQ, PSQI, and SHI. Sleep diaries were used as a tracking system by 5 studies. Different actigraphy where used on the research, the list of brands is displayed in a figure 3 with the number of times used.

Table 10

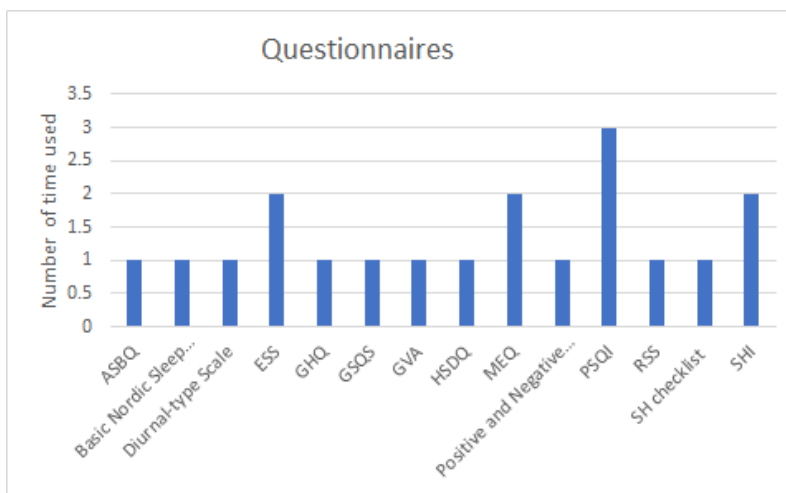
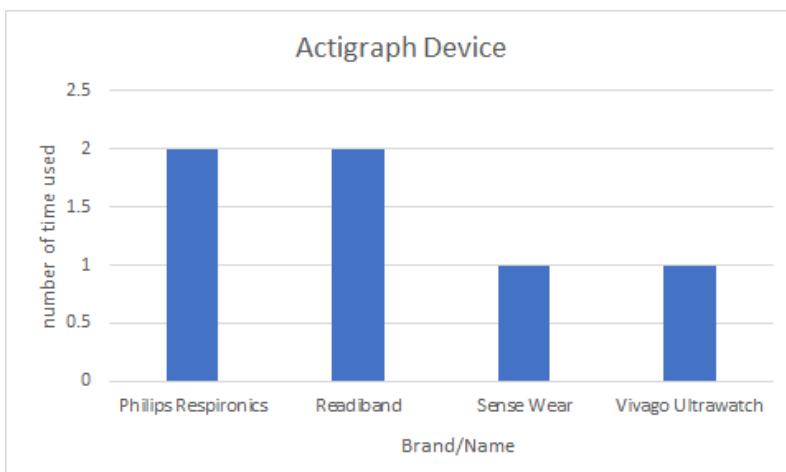


Table 9





The sample size varied from 10 to 891. However, it seems that when the sample sized was high studies only tracked the sleep improvement by questionnaires. The dominant gender in the sample population was male (6 where all men studies). Only 1 study used an all-female sample, and 4 research used a mixed population. The time ranged varied from 2 weeks to 1 year. Only 1 research had a duration of over a year, 5 studies lasted at least 4 weeks, but less than 6 months and 3 research were under 4 weeks period.

In terms of sleep variables, 2 studies found no difference between the control group and variable; 4 studies found a higher TST, lower WV, and WED were only found once, a higher SE was present in 1 journal, a higher WE was stated once. Out of the total, 5 articles recommended the use of sleep hygiene to find better performance and recovery and 2 studies mention a higher sleep quality. From the entire selection, only 1 article presented that even when sleep hygiene was violated the sleep quality was better if sleeping was done at night, instead than during the day. The article by Driller et al. (2018), was not included in these results because their study was aimed to create a new sleep questionnaire that was addressed strictly to athletes. Still, the study by Driller et al. (2018), was included in the review tables (Tables 6, 7 and 8) because they introduce part of the SHI (sleep hygiene index) to their final questionnaire due to the importance of sleep hygiene.

Out of 16 studies, 5 were a literature review, 4 were based on questionnaires, 2 used only actigraphy, and 6 used a mix of tracking modalities (questionnaires, actigraphy and sleep diaries). Out of these, 6 studies did not present a specified sleep hygiene strategies nor provided a list of habits that the athletes were recommended to follow; they were rather vague. Of the total, 7 of the journal articles used specific sleep hygiene recommendations which are all included in

the table 8. The list of sleep hygiene recommendations are included in figure 4, which includes any habit that was mentioned at least 2 times, and the number times that the recommendation was mentioned.

*Table 11 (Specific sleep hygiene recommendations found)*

Reference	Sleep Hygiene Recommendations
Copenhaver et al. (2017).	<ul style="list-style-type: none"> <li>• Bright morning light maintain consistent bedtime on both weekdays and weekends,</li> <li>• Avoid evening light exposure from technology,</li> <li>• Maintain an optimal bedroom sleeping temperature,</li> <li>• Engage in activities to relax and prepare for bed at least 30 min prior to bed,</li> <li>• Limit caffeine intake.</li> </ul>
Bird, (2013).	<ul style="list-style-type: none"> <li>• Maintain a regular schedule of going to bed and waking up.</li> <li>• If you cannot sleep within 15 minutes, get out of bed and try performing a mundane task,</li> <li>• Eliminate bedroom clock,</li> <li>• Avoid coffee, alcohol, and nicotine in the hours before bed,</li> <li>• Avoid watching television, eating, working or reading in bed,</li> <li>• Be conscious of food and fluid intake before bedtime,</li> <li>• Nap appropriately,</li> <li>• Maintain a room temperature comfortable for sleeping.</li> </ul>
Fullagar, et al. (2015)	<ul style="list-style-type: none"> <li>• No technology 30 min before bedtime,</li> <li>• No TV or use of a laptop in bed,</li> <li>• Have a dark, cool (but not cold), quiet room (blinds closed),</li> <li>• Set a regular sleep schedule where possible and introduce relaxation and meditation techniques if necessary.</li> </ul>
Fullagar, et al. (2016)	<ul style="list-style-type: none"> <li>• Proceed to their bedrooms at 23:45 in preparation of sleep,</li> <li>• Lights dimmed and provide earplugs and eye mask,</li> <li>• No technology or light stimulation for 15 to 30 minutes before bed,</li> <li>• Lights must be turned off by 00:00</li> </ul>

Harada, et al. (2016)	<ul style="list-style-type: none"> <li>• Early morning exposure to sunlight,</li> <li>• Sunlight exposure after breakfast,</li> <li>• Use of lighting emitting low-color-temperature lights,</li> <li>• Protein-rich breakfast,</li> <li>• Limitation to watching TV at night, limitation of PC use at night, limitation of playing an electric game at night,</li> <li>• Recording of sleep diary</li> </ul>
Nédélec, et al. (2013)	<ul style="list-style-type: none"> <li>• Use of glasses fitted with short-wavelength filter after the match,</li> <li>• Consume high-electrolyte fluids between cessation of match and bedtime,</li> <li>• Consume a high glycemic index meal,</li> <li>• Consume protein immediately prior to sleep,</li> <li>• Consume Montmorency tart cherry juice concentrate and/or tryptophan-containing food,</li> <li>• Use recovery strategies aimed at reducing muscle soreness,</li> <li>• Create a low-light and cool sleep environment,</li> <li>• Void all electronic stimulants in the hour prior to sleep,</li> <li>• Eliminate the bedroom clock,</li> <li>• Explore the use of brain entrainment and meditation,</li> <li>• Use acute dawn-simulation therapy during the last 30 minutes prior to waking,</li> <li>• Have a regular bedtime/wake time and avoid sleeping too late in the morning off days,</li> <li>• Nap briefly and appropriately,</li> <li>• Engage in active daytime behaviors and bright morning light exposure during off days.</li> </ul>
O'Donnell, et al. (2017)	<ul style="list-style-type: none"> <li>• Maintaining a regular bed and wake time,</li> <li>• Ensuring quiet, cool and dark bedroom environment,</li> <li>• Avoidance of caffeine and other stimulants prior to sleep,</li> <li>• Avoidance of light-emitting technology devices in the hours prior to sleep,</li> <li>• Implementation of relaxation strategies before bed.</li> </ul>

Table 12 (Sleep hygiene habits)



## V. DISCUSSION:

Gupta, Morgan, and Gilchrist (2017), performed research on sleep quality and insomnia among athletes and report this topic is still unexplored in sports science and medical literature. There is little information or recommendations on how to treat sleep disorders in athletes (Fullagar et al., 2016). A way to decrease sleep deprivation is by incorporating sleep hygiene education into the athlete program (Nédélec et al., 2015). In the study “Optimizing sleep to maximize performance: Implications and recommendations for elite athletes” the authors compiled a list of suggestions to improve sleep in athletes, and they included a list of healthy sleep habits (sleep hygiene) (Simpson, Gibbs, & Matheson, 2017).

Sleep hygiene education provides the athletes with a robust framework on various aspects of lifestyle and behavior (De Sousa et al., 2007). Education on sleep hygiene might improve athletes overall sleep time, resulting in a better performance (Bonnar et al., 2018; H. H. K. Fullagar, Duffield, et al., 2015; H. Fullagar et al., 2016; Knufinke, Nieuwenhuys, Geurts, Coenen, & Kompier, 2018; O'Donnell & Driller, 2017). Nédélec et al. (2015), reported the constraints that elite soccer players say are highly associated with inadequate sleep hygiene. Harada et al. (2016), showed that during the month the athletes were being intervened the sleep latency and slept depth was significantly longer and shallower. Lastella and others (2015), stated that sleep hygiene practices would introduce athletes to strategies that will help them improve their sleep quantity and quality. Tuomilehto et al. (2017), included that even athletes themselves stated that if they received better guidance about sleep, it could influence on their performance.

Hoshikawa et al. (2018), investigations highlighted a necessary relation between poor sleep quality and hygiene-factors; these factors varied according to sex. For males, it seems that

TTB, sleep hygiene factor thinking about trouble in bed and the depressive mood correlated to poor sleep quality. For females, having an irregular get up time and thinking about troubles in bed, depressive mood and WT were associated with poor sleep quality. A the study found that only less than 20% of athletes responded that they avoid the use of electronic devices before bed (Hoshikawa et al., 2018).

O'Donnell and Driller (2017), made a similar conclusion in their literature review where most sleep studies using sleep hygiene had a similar TST, but a difference in SL. O'Donnell and Driller (2017), explained that the cause could be the time in the athletes training; if they had practice at night, it could affect their core temperature delaying the SOT. Another result found was low percentages on SE. Though, Fullagar et al. (2015) explained that forcing athletes to extend their TBT will not improve their TST if they are not under sleep deprivation. Caia et al.(2018) had the same explanation that even when the sleep education session encourages athletes to an earlier bedtime, the SOT was later, resulting in a lower SE.

The limitations to comparing these studies are the distinction in their sleep-assessment methodologies (e.g., the difference between the actigraph brand, the variation of the sleep questionnaires, and the sleep diaries structures) and each methodology includes their own margin of error. Some reports only used 1 tracking system; the combination of 2 methods (i.e., sleep diary and actigraphy) can increase the accuracy of the results. The use of a combination of methods helps to obtain a better perception of the athletes' subjective measures of their sleep. O'Donell and Driller (2017), stated that 1 limitation of their study was that they only used actigraphy, obtaining only objective results. The researchers admitted that the combined use of sleep diaries could have amplified their investigation with more accurate results, and capture

more details of the outcomes of the sleep hygiene education session(O'Donnell & Driller, 2017). On the same track, Hoshikawa et al.(2018), stated that their investigation limitation was that they only used questionnaires, and these are not objective measures.

A discrepancy was found in athletes' sleep reports. Even when the actigraphy-based sleep ranked them with optimal sleep quality, their self-report (journals, questionnaires) indicated the opposite, athletes reported waking up fatigued and not well rested (Krystal & Edinger, 2008). An athlete could be sleeping the same total hours as a healthy control group; however; there is a significant difference in the parameters (Leeder et al., 2012).Van Ryswyk et al. (2017) had the same discrepancy in their results; a sleep education had a significant improvement in the athletes self-reported (sleep diaries) SE, TST, vigor, and fatigue. Still, the actigraphs trackers did not showed the same results; they did not find any improvement compared with the baseline measures. Van Ryswyk et al. (2017), gave 2 explanations to this either athletes were over-estimating their TST, and the desire to show adherence to the recommendation (Marino et al., 2013). The second alternative is that the settings on the actigraphy made an underestimation of the TST. Sargent, Lastella, Halson, and Roach (2016), had an investigation that compared the results from polysomnography vs. an actigraph. The journal article by Sargent et al. (2016), concluded that the actigraphs underestimated the TST by approximately 50 minutes and overestimated wake duration by 40 minutes. Sargent et al. (2016), stated that the use of the actigraphy is still useful if they are adapted to an appropriate sleep/wake threshold; athletes need a higher sensitivity device.

Some authors argue that the questionnaires used to evaluate sleep are not directed nor accurate when applying to athletes. Scholars such as Samuels et al. (2016), considered that the

PSQI ranked the athletes sleep higher than what athletes were reporting. These critics stated that the standard questionnaires were designed for the general population and did not take into account the limitations and restriction athletes endure (Samuels et al., 2016). The Athlete Sleep Screening Questionnaire (ASSQ) was developed for athletes, and its state to have good reliability based on test-retest percentage agreement (Samuels et al., 2016). Driller and colleagues (2018), claimed that there was still a gap in the questionnaire ASSQ to provide behavioral modification based on response and individualized feedback, to fill this gap they develop the Athlete Sleep Behavior Questionnaire (ASBQ). The ASBQ combines the international classification of sleep disorders, sleep hygiene index, and the previous recommendation made to elite athletes to addresses sleep disorders. At an earlier literature review, it is stated that to obtain more meaningful outcomes the use of sleep questionnaires directed to athletes needs to be used (Bonnar et al., 2018).

Another limitation was encounter in the sample population. Each author had a different interpretation of what an athlete is; some used as a sample of elite athletes, others used people that exercise daily. Some mention college and high schooler athletes, which are a completely different case scenario since they not only have strict training schedules, they also have to fit classes and study time in their day. The predominance of males provides a partial result; females have different results because their menstrual cycle seemed to influence their sleep patterns (Manber & Bootzin, 1997).

As of sleep hygiene strategies, only 7 out of the 16 studies presented a specified list. Though the other just stated that they included sleep hygiene habits without describing which ones. This issue makes it impossible to give an accurate result and to draw a conclusion since is



unknown which strategies were used on those articles. This thesis failed to encounter any 2 studies that implement an identical set of sleep hygiene recommendations.

On the systematic review made by Bonnar et al. (2018), highlighted that sleep hygiene studies use to miss an adequate control group making it seem that the sleep hygiene sessions did not have any impact on the athletes observed. When the reviews were based on baseline measurements, these were obtained in 1 to 2 weeks, and we believe that these are not accurate, since an athlete's schedule changes depending on their stage in their season.

As discussed in the literature review section for sleep hygiene is also refer to sleep habits (Mastin et al., 2006). Sleep hygiene is a list of recommendations and habits to improve sleep quality. The term "habits" is defined as "behavioral patterns enacted automatically in response to a situation in which the behavior has been performed repeatedly and consistently in the past" (Lally & Gardner, 2013, p. S137). The journal article described habit as a behavior that has been repeated in a consistent setting, and the person begins to process the action with less thought as control of the behavior and with more efficiency, this will later transfer into an automatic response (Lally, van Jaarsveld, Potts, & Wardle, 2010).

A study performed by Lally et al. (2010), made an investigation to see how long it would take to form a habit. They asked 96 participants to perform the same habit for 84 days and to log every day if they had performed the behavior as well as to complete a self-report habit index (SRHI). This index measures lack awareness, efficiency, and lack of control. They came out with the conclusion that the mean time to acquire a habit is 66 days, and the range was from 18 to 254 days. As well, they found out that missing a day did not affect the long-term results (Lally et al., 2010). The correlation found by Lally and colleagues (2010), revokes the statement made by

Maltz (1999) which proclaims that only 21 days are needed to form a habit. The time ranged of the investigations on sleep hygiene on athletes ranged from 2 weeks to 1 year, only 1 of them was over a year. Out of all research, only 3 of the research came up with conclusions under 4 weeks, resulting in less than the mean time of 66 days to form a habit.

Studies like the one by Harris et al. (2015), which had an adverse outcome or found no difference after a sleep hygiene education could have been because of the limitation mention above. In the case of the investigation by Harris et al. (2015) it only lasted 4 weeks, and they even mention that they selected an hour to enforce the restriction of the electronic devices too late and too close to the bedtime, meaning that the use of the devices until 22:00 could still be affecting the athletes sleep.

## VI. CONCLUSION:

After an entire review of 16 articles, most of them seem to come to the same conclusion. The implementation of sleep hygiene education could improve the overall quality of the athletes' sleep. Sleep hygiene education could serve as an easy and reliable approach to enhance athletes' rest and does not require any help from a professional. Yet, the current implementation and strategies used in these articles for sleep hygiene education are vague and lack precision leading to error or a gap of unknown variables. To avoid inconsistency in the finding of the studies in athletes' sleep a standardized list of sleep hygiene recommendations and habits need to be created. The creation of the new list of sleep hygiene habits must be develop focused on athletes restrains and constrains. Future research should be focused on creating a new standardized list of sleep hygiene and using appropriate sleep-assessment measurement for athletes (i.e., questionnaires and actigraphy).

## VII. REFERENCE:

- American Academy of Sleep Medicine. (2001). *ICSD The International Classification of Sleep Disorders, Revised: Diagnostic and Coding Manual*. Chicago, IL: American Academy of Sleep Medicine.
- American Sleep Disorders Association. (1990). *International Classification of Sleep Disorder: Diagnostic and Coding Manual*. Rochester, MN: American Sleep Disorder Association.
- American Sleep Disorders Association. (1997). *The international classification of sleep disorders revised: Diagnostic and coding manual*. Rochester, MN: American Sleep Disorder Association.
- Aminoff, M. J., Boller, F., & Swaab, D. F. (2011). We Spend about one-third of our life either sleeping or attempting to do so. In *Handbook of Clinical Neurology* (Vol. 98, p. vii). <https://doi.org/10.1016/B978-0-444-52006-7.00047-2>
- Atkinson, G., Drust, B., Reilly, T., & Waterhouse, J. (2003). The Relevance of Melatonin to Sports Medicine and Science: *Sports Medicine*, 33(11), 809–831. <https://doi.org/10.2165/00007256-200333110-00003>
- Berger, A. M., VonEssen, S., Kuhn, B. R., Piper, B. F., Farr, L., Agrawal, S., ... Higginbotham, P. (2002). Feasibility of a Sleep Intervention During Adjuvant Breast Cancer Chemotherapy. *Oncology Nursing Forum*, 29(10), 1431–1441. <https://doi.org/10.1188/02.ONF.1431-1441>
- Bird, S. P. (2013). Sleep, Recovery, and Athletic Performance: A Brief Review and Recommendations. *Strength and Conditioning Journal*, 5.

- Bjorvatn, B., & Pallesen, S. (2009). A practical approach to circadian rhythm sleep disorders. *Sleep Medicine Reviews*, 13(1), 47–60. <https://doi.org/10.1016/j.smrv.2008.04.009>
- Bonnar, D., Bartel, K., Kakoschke, N., & Lang, C. (2018). Sleep Interventions Designed to Improve Athletic Performance and Recovery: A Systematic Review of Current Approaches. *Sports Medicine*, 48(3), 683–703. <https://doi.org/10.1007/s40279-017-0832-x>
- Borbély, A. A. (1982). Sleep Regulation: Circadian Rhythm and Homeostasis. In D. Ganten & D. Pfaff (Eds.), *Sleep* (Vol. 1, pp. 83–103). [https://doi.org/10.1007/978-3-642-68333-6\\_3](https://doi.org/10.1007/978-3-642-68333-6_3)
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)
- Caia, J., Scott, T. J., Halson, S. L., & Kelly, V. G. (2018). The influence of sleep hygiene education on sleep in professional rugby league athletes. *Sleep Health*, 4(4), 364–368. <https://doi.org/10.1016/j.sleh.2018.05.002>
- Calder, A. (2003, September). Recovery strategies for sports performance. *USOC Olympic Coach E-Magazine 2003*. Retrieved from <http://coaching.usolympicteam.com/coaching/kpub.nsf/v/3Sept03>.
- Cole, R. J. (2005). Nonpharmacologic Techniques for Promoting Sleep. *Clinics in Sports Medicine*, 24(2), 343–353. <https://doi.org/10.1016/j.csm.2004.12.010>
- Copenhaver, E. A., & Diamond, A. B. (2017). The Value of Sleep on Athletic Performance, Injury, and Recovery in the Young Athlete. *Pediatric Annals*, 46(3), e106–e111. <https://doi.org/10.3928/19382359-20170221-01>

- Coutts, A. J., Reaburn, P., Piva, T. J., & Rowsell, G. J. (2007). Monitoring for overreaching in rugby league players. *European Journal of Applied Physiology*, 99(3), 313–324.  
<https://doi.org/10.1007/s00421-006-0345-z>
- Davenne, D. (2009). Sleep of athletes – problems and possible solutions. *Biological Rhythm Research*, 40(1), 45–52. <https://doi.org/10.1080/09291010802067023>
- De Sousa, I. C., Araújo, J. F., & De Azevedo, C. V. M. (2007). The effect of a sleep hygiene education program on the sleep/wake cycle of Brazilian adolescent students. *Sleep and Biological Rhythms*, 5(4), 251–258. <https://doi.org/10.1111/j.1479-8425.2007.00318.x>
- Dennis, J., Dawson, B., Heasman, J., Rogalski, B., & Robey, E. (2016). Sleep patterns and injury occurrence in elite Australian footballers. *Journal of Science and Medicine in Sport*, 19(2), 113–116. <https://doi.org/10.1016/j.jsams.2015.02.003>
- Driller, M., McQuillan, J., & O'Donnell, S. (2016). Inter-device reliability of an automatic-scoring actigraph for measuring sleep in healthy adults. *Sleep Science*, 9(3), 198–201. <https://doi.org/10.1016/j.slsci.2016.08.003>
- Driller, M. W., Mah, C. D., & Halson, S. L. (2018). Development of the athlete sleep behavior questionnaire: A tool for identifying maladaptive sleep practices in elite athletes. *Sleep Science*, 11(1), 37–44. <https://doi.org/10.5935/1984-0063.20180009>
- Duffield, R., Murphy, A., Kellett, A., & Reid, M. (2014). Recovery from Repeated On-Court Tennis Sessions: Combining Cold-Water Immersion, Compression, and Sleep Interventions. *International Journal of Sports Physiology and Performance*, 9(2), 273–282. <https://doi.org/10.1123/ijsp.2012-0359>

- Eagles, A., Mclellan, C., Hing, W., Carloss, N., & Lovell, D. (2014). Changes in sleep quantity and efficiency in professional rugby union players during home based training and match-play. *The Journal of Sports Medicine and Physical Fitness*.
- Ford, E. S., Wheaton, A. G., Cunningham, T. J., Giles, W. H., Chapman, D. P., & Croft, J. B. (2014). Trends in Outpatient Visits for Insomnia, Sleep Apnea, and Prescriptions for Sleep Medications among US Adults: Findings from the National Ambulatory Medical Care Survey 1999-2010. *Sleep*, 37(8), 1283–1293. <https://doi.org/10.5665/sleep.3914>
- Fowler, P. M., Paul, D. J., Tomazoli, G., Farooq, A., Akenhead, R., & Taylor, L. (2017). Evidence of sub-optimal sleep in adolescent Middle Eastern academy soccer players which is exacerbated by sleep intermission proximal to dawn. *European Journal of Sport Science*, 17(9), 1110–1118. <https://doi.org/10.1080/17461391.2017.1341553>
- Frank, M. G., & Benington, J. H. (2006). The Role of Sleep in Memory Consolidation and Brain Plasticity: Dream or Reality? *The Neuroscientist*, 12(6), 477–488. <https://doi.org/10.1177/1073858406293552>
- Fullagar, H. H. K., Duffield, R., Skorski, S., Coutts, A. J., Julian, R., & Meyer, T. (2015). Sleep and Recovery in Team Sport: Current Sleep-Related Issues Facing Professional Team-Sport Athletes. *International Journal of Sports Physiology and Performance*, 10(8), 950–957. <https://doi.org/10.1123/ijsp.2014-0565>
- Fullagar, H. H. K., Skorski, S., Duffield, R., Hammes, D., Coutts, A. J., & Meyer, T. (2015). Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise. *Sports Medicine*, 45(2), 161–186. <https://doi.org/10.1007/s40279-014-0260-0>

- Fullagar, H., Skorski, S., Duffield, R., & Meyer, T. (2016). The effect of an acute sleep hygiene strategy following a late-night soccer match on recovery of players. *Chronobiology International*, 33(5), 490–505. <https://doi.org/10.3109/07420528.2016.1149190>
- Gupta, L., Morgan, K., & Gilchrist, S. (2017). Does Elite Sport Degrade Sleep Quality? A Systematic Review. *Sports Medicine*, 47(7), 1317–1333. <https://doi.org/10.1007/s40279-016-0650-6>
- Halson, S. L. (2008). Nutrition, sleep and recovery. *European Journal of Sport Science*, 8(2), 119–126. <https://doi.org/10.1080/17461390801954794>
- Halson, S. L. (2013). *Sleep and elite athlete*. 26(113), 1–4.
- Halson, S. L. (2014). Sleep in Elite Athletes and Nutritional Interventions to Enhance Sleep. *Sports Medicine*, 44(S1), 13–23. <https://doi.org/10.1007/s40279-014-0147-0>
- Harada, T., Wada, K., Tsuji, F., Krejci, M., Kawada, T., Noji, T., ... Takeuchi, H. (2016). Intervention study using a leaflet entitled ‘three benefits of “go to bed early! get up early! and intake nutritionally rich breakfast!” a message for athletes’ to improve the soccer performance of university soccer team. *Sleep and Biological Rhythms*, 14(S1), 65–74. <https://doi.org/10.1007/s41105-015-0035-5>
- Harris, A., Gundersen, H., Mørk-Andreassen, P., Thun, E., Bjorvatn, B., & Pallesen, S. (2015). Restricted use of electronic media, sleep, performance, and mood in high school athletes—a randomized trial. *Sleep Health*, 1(4), 314–321. <https://doi.org/10.1016/j.sleh.2015.09.011>
- Hauri, P. J. (1977). *The Sleep disorders. Current Concepts*. Kalamazoo, MI: Scope Publications, Upjohn.



- Hauri, P. J. (1991). Sleep Hygiene, Relaxation Therapy, and Cognitive Interventions. In P. J. Hauri (Ed.), *Case Studies in Insomnia* (pp. 65–84). [https://doi.org/10.1007/978-1-4757-9586-8\\_5](https://doi.org/10.1007/978-1-4757-9586-8_5)
- Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology*, 4(2), 97–110.
- Hoshikawa, M., Uchida, S., & Hirano, Y. (2018). A Subjective Assessment of the Prevalence and Factors Associated with Poor Sleep Quality Amongst Elite Japanese Athletes. *Sports Medicine - Open*, 4(1), 10. <https://doi.org/10.1186/s40798-018-0122-7>
- Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J., & Hall, M. H. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. *Sleep Medicine Reviews*, 22, 23–36. <https://doi.org/10.1016/j.smrv.2014.10.001>
- Johns, M. W. (1991). A New Method for Measuring Daytime Sleepiness: The Epworth Sleepiness Scale. *Sleep*, 14(6), 540–545. <https://doi.org/10.1093/sleep/14.6.540>
- Juliff, L. E., Halson, S. L., Hebert, J. J., Forsyth, P. L., & Peiffer, J. J. (2018). Longer Sleep Durations Are Positively Associated With Finishing Place During a National Multiday Netball Competition: *Journal of Strength and Conditioning Research*, 32(1), 189–194. <https://doi.org/10.1519/JSC.0000000000001793>
- Kakinuma, M., Takahashi, M., Kato, N., Aratake, Y., Watanabe, M., Ishikawa, Y., ... Tanaka, K. (2010). Effect of Brief Sleep Hygiene Education for Workers of an Information Technology Company. *Industrial Health*, 48(6), 758–765. <https://doi.org/10.2486/indhealth.MS1083>

Kawada, T. (2008). Agreement rates for sleep/wake judgments obtained via accelerometer and sleep diary: A comparison. *Behavior Research Methods*, 40(4), 1026–1029.

<https://doi.org/10.3758/BRM.40.4.1026>

Kellmann, M. (2010). Preventing overtraining in athletes in high-intensity sports and stress/recovery monitoring: Preventing overtraining. *Scandinavian Journal of Medicine & Science in Sports*, 20, 95–102. <https://doi.org/10.1111/j.1600-0838.2010.01192.x>

Killer, S. C., Svendsen, I. S., Jeukendrup, A. E., & Gleeson, M. (2017). Evidence of disturbed sleep and mood state in well-trained athletes during short-term intensified training with and without a high carbohydrate nutritional intervention. *Journal of Sports Sciences*, 35(14), 1402–1410. <https://doi.org/10.1080/02640414.2015.1085589>

Knufinke, M., Nieuwenhuys, A., Geurts, S. A. E., Coenen, A. M. L., & Kompier, M. A. J. (2018). Self-reported sleep quantity, quality and sleep hygiene in elite athletes. *Journal of Sleep Research*, 27(1), 78–85. <https://doi.org/10.1111/jsr.12509>

Krystal, A. D., & Edinger, J. D. (2008). Measuring sleep quality. *Sleep Medicine*, 9, S10–S17. [https://doi.org/10.1016/S1389-9457\(08\)70011-X](https://doi.org/10.1016/S1389-9457(08)70011-X)

Lack, L. C., & Wright, H. R. (2007). Chronobiology of sleep in humans. Cellular and Molecular Life Science. *Cellular and Molecular Life Sciences*, 64(10), 1205–1215. <https://doi.org/10.1007/s00018-007-6531-2>

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review*, 7(sup1), S137–S158. <https://doi.org/10.1080/17437199.2011.603640>

- Lally, P., van Jaarsveld, C. H. M., Potts, H. W. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology*, 40(6), 998–1009. <https://doi.org/10.1002/ejsp.674>
- Lane, A. M. (2000). Mood and Emotion in Sport: A Response to Jones, Mace, and Williams (2000). *Perceptual and Motor Skills*, 91(2), 649–652. <https://doi.org/10.2466/pms.2000.91.2.649>
- Lastella, M., Roach, G. D., Halson, S. L., & Sargent, C. (2015). Sleep/wake behaviours of elite athletes from individual and team sports. *European Journal of Sport Science*, 15(2), 94–100. <https://doi.org/10.1080/17461391.2014.932016>
- Leeder, J., Glaister, M., Pizzoferro, K., Dawson, J., & Pedlar, C. (2012). Sleep duration and quality in elite athletes measured using wristwatch actigraphy. *Journal of Sports Sciences*, 30(6), 541–545. <https://doi.org/10.1080/02640414.2012.660188>
- Luke, A., Lazaro, R. M., Bergeron, M. F., Keyser, L., Benjamin, H., Brenner, J., ... Smith, A. (2011). Sports-Related Injuries in Youth Athletes: Is Overscheduling a Risk Factor?: *Clinical Journal of Sport Medicine*, 21(4), 307–314. <https://doi.org/10.1097/JSM.0b013e3182218f71>
- 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>
- Mahoney, M. J., & Avenier, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy and Research*, 1(2), 135–141. <https://doi.org/10.1007/BF01173634>
- Maltz, M. (1999). *Psycho-cybernetics*. New York; London: Pocket Books.

- Manber, R., & Bootzin, R. R. (1997). Sleep and the menstrual cycle. *Health Psychology, 16*(3), 209–214. <https://doi.org/10.1037/0278-6133.16.3.209>
- Marino, M., Li, Y., Rueschman, M. N., Winkelman, J. W., Ellenbogen, J. M., Solet, J. M., ... Buxton, O. M. (2013). Measuring Sleep: Accuracy, Sensitivity, and Specificity of Wrist Actigraphy Compared to Polysomnography. *Sleep, 36*(11), 1747–1755. <https://doi.org/10.5665/sleep.3142>
- Mastin, D. F., Bryson, J., & Corwyn, R. (2006). Assessment of Sleep Hygiene Using the Sleep Hygiene Index. *Journal of Behavioral Medicine, 29*(3), 223–227. <https://doi.org/10.1007/s10865-006-9047-6>
- McNair, D., Lorr, M., Droppleman, L., & Educational and Industrial Testing Service. (1971). *Profile of mood states*. San Diego, CA: Educational and Industrial Testing Service.
- Meyer, T., Wegmann, M., Poppendieck, W., & Fullagar, H. H. K. (2014). Regenerative interventions in professional football. *Sport-Orthopädie - Sport-Traumatologie - Sports Orthopaedics and Traumatology, 30*(2), 112–118. <https://doi.org/10.1016/j.orthtr.2014.04.009>
- Nédélec, M., Halson, S., Delecroix, B., Abaidia, A.-E., Ahmaidi, S., & Dupont, G. (2015). Sleep Hygiene and Recovery Strategies in Elite Soccer Players. *Sports Medicine, 45*(11), 1547–1559. <https://doi.org/10.1007/s40279-015-0377-9>
- Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2013). Recovery in Soccer: Part II—Recovery Strategies. *Sports Medicine, 43*(1), 9–22. <https://doi.org/10.1007/s40279-012-0002-0>

- O'Donnell, S., & Driller, M. W. (2017). *Sleep-hygiene Education improves Sleep Indices in Elite Female Athletes*. 9.
- Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of Sleep Deprivation on Performance: A Meta-Analysis. *Sleep*, 19(4), 318–326. <https://doi.org/10.1093/sleep/19.4.318>
- PRISMA-P Group, Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., ... Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews*, 4(1), 1. <https://doi.org/10.1186/2046-4053-4-1>
- Sadeh, A. (2011). The role and validity of actigraphy in sleep medicine: An update. *Sleep Medicine Reviews*, 15(4), 259–267. <https://doi.org/10.1016/j.smr.2010.10.001>
- Samuels, C. (2008). Sleep, Recovery, and Performance: The New Frontier in High-Performance Athletics. *Neurologic Clinics*, 26(1), 169–180. <https://doi.org/10.1016/j.ncl.2007.11.012>
- Samuels, C. (2012). Jet Lag and Travel Fatigue: A Comprehensive Management Plan for Sport Medicine Physicians and High-Performance Support Teams. *Clinical Journal of Sport Medicine*, 22(3), 268–273. <https://doi.org/10.1097/JSM.0b013e31824d2eeb>
- Samuels, C., James, L., Lawson, D., & Meeuwisse, W. (2016). The Athlete Sleep Screening Questionnaire: a new tool for assessing and managing sleep in elite athletes. *British Journal of Sports Medicine*, 50(7), 418–422. <https://doi.org/10.1136/bjsports-2014-094332>
- Sargent, C., Lastella, M., Halson, S. L., & Roach, G. D. (2016). The validity of activity monitors for measuring sleep in elite athletes. *Journal of Science and Medicine in Sport*, 19(10), 848–853. <https://doi.org/10.1016/j.jsams.2015.12.007>

- Simpson, N. S., Gibbs, E. L., & Matheson, G. O. (2017). Optimizing sleep to maximize performance: implications and recommendations for elite athletes. *Scandinavian Journal of Medicine & Science in Sports*, 27(3), 266–274. <https://doi.org/10.1111/sms.12703>
- Souissi, N., Chtourou, H., Aloui, A., Hammouda, O., Dogui, M., Chaouachi, A., & Chamari, K. (2013). Effects of Time-of-Day and Partial Sleep Deprivation on Short-Term Maximal Performances of Judo Competitors: *Journal of Strength and Conditioning Research*, 27(9), 2473–2480. <https://doi.org/10.1519/JSC.0b013e31827f4792>
- Stepanski, E. J., & Wyatt, J. K. (2003). Use of sleep hygiene in the treatment of insomnia. *Sleep Medicine Reviews*, 7(3), 215–225. <https://doi.org/10.1053/smr.2001.0246>
- Stickgold, R. (2005). Sleep-dependent memory consolidation. *Nature*, 437(7063), 1272–1278. <https://doi.org/10.1038/nature04286>
- Taylor, S. R., Rogers, G. G., & Driver, H. S. (1997). Effects of training volume on sleep, psychological, and selected physiological profiles of elite female swimmers: *Medicine & Science in Sports & Exercise*, 29(5), 688–693. <https://doi.org/10.1097/00005768-199705000-00016>
- Tuomilehto, H., Vuorinen, V.-P., Penttilä, E., Kivimäki, M., Vuorenmaa, M., Venojärvi, M., ... Pihlajamäki, J. (2017). Sleep of professional athletes: Underexploited potential to improve health and performance. *Journal of Sports Sciences*, 35(7), 704–710. <https://doi.org/10.1080/02640414.2016.1184300>
- Van Maanen, A., Roest, B., Moen, M., Oort, F., Vergouwen, P., Paul, I., ... Smits, M. (2015). Extreme Violation of Sleep Hygiene: Sleeping Against the Biological Clock During a

- Multiday Relay Event. *Asian Journal of Sports Medicine*, 6(4).  
<https://doi.org/10.5812/asjasm.25678>
- Van Ryswyk, E., Weeks, R., Bandick, L., O’Keefe, M., Vakulin, A., Catcheside, P., ... Antic, N. A. (2017). A novel sleep optimisation programme to improve athletes’ well-being and performance. *European Journal of Sport Science*, 17(2), 144–151.  
<https://doi.org/10.1080/17461391.2016.1221470>
- Venter, R. E. (2014). Perceptions of team athletes on the importance of recovery modalities. *European Journal of Sport Science*, 14(sup1), S69–S76.  
<https://doi.org/10.1080/17461391.2011.643924>
- Williamson, A. M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occupational and Environmental Medicine*, 57(10), 649–655.  
<https://doi.org/10.1136/oem.57.10.649>
- Winter, C., Hammond, W. R., Green, N. H., Zhang, Z., & Bliwise, D. L. (2009). Measuring Circadian Advantage in Major League Baseball: A 10-Year Retrospective Study. *International Journal of Sports Physiology and Performance*, 4(3), 394–401.  
<https://doi.org/10.1123/ijsp.4.3.394>
- Yoo, S.-S., Gujar, N., Hu, P., Jolesz, F. A., & Walker, M. P. (2007). The human emotional brain without sleep — a prefrontal amygdala disconnect. *Current Biology*, 17(20), R877–R878.  
<https://doi.org/10.1016/j.cub.2007.08.007>

Zarcone, V. (2003). Sleep Hygiene. In M. H. Kryger, T. Roth, & W. C. Dement (Eds.),  
*Principles and practice of sleep medicine* (3rd ed., pp. 215–225). Philadelphia, PA: WB  
Saunders.