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Sleep in College Club Athletes: Patterns, Correlates, and Comparisons with College Non-Athletes

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Psychological Science

by

Dmitry Tsukerman

Dissertation Committee:
Professor Susan Charles, Co-Chair
Associate Professor Angela Lukowski, Co-Chair
Professor Larry Jamner

2020

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ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to the very special people in my academic and personal lives who have both directly and indirectly made this dissertation possible. To those who have contributed to my journey but are not mentioned here, I truly hope that I have demonstrated my gratitude to you in other ways.

First, I would like to thank the co-chairs of my dissertation, Drs. Susan Charles and Angela Lukowski. The two of you welcomed me into this school and department together, offering me the tremendous opportunity to learn from each of your unique styles of mentorship and approaches to research and writing. I have been extremely fortunate to have two mentors that patiently and wholeheartedly supported me in developing my own research interests and career aspirations. I hope to someday live up to the examples and standards of professionalism, productivity, ingenuity, and kindness that you continue to set for me. I am blessed for the five years I have spent under your guidance and envy the next generation of students that are only beginning their time with you.

I would next like to thank my third dissertation committee member, Dr. Larry Jamner. From the first conversations we had together in brainstorming methodology for the study, to our most recent conversation discussing the final product during my defense, you have shown me unwavering interest, support, and positivity. You have assisted me intellectually, instrumentally, and emotionally in making this project a reality, and I consider myself exceptionally fortunate as the recipient of your kindness and wisdom.

I would also like to thank Dr. Joanne Zinger, whose role on my dissertation proposal committee was just a small piece of her overarching support throughout my doctoral studies. From my first quarter as a graduate student, you entrusted me with the singular role as graduate advisor for your Post-baccalaureate program, a role which I have cherished throughout my entire five years at UCI. The great joy and satisfaction I have felt throughout my time as an advisor have largely shaped my future career goals and I will forever aspire to reach your tremendous professionalism, hard work, and ambition.

I also owe a big thanks to Dr. Bryce Mander, who so graciously agreed to serve on my dissertation proposal committee after one wonderfully informative conversation about my study ideas. In the kindest and most open manner, you lent me your advice and expertise, which greatly shaped the methodology and scope of my dissertation studies. I am extremely grateful for your time, wisdom, and support.

I would also like to thank my friends and peers at UCI who have shared this academic journey with me from day one. You have played so many roles throughout my graduate studies; you have been my confidants, allies, and teammates, as well as my heroes, advisors, and teachers. I will forever cherish the academic, personal, and professional journeys through which

we trekked together. I thank you for your tremendous support, kindness, entertainment, and inspiration in helping me reach this great milestone in my life.

Next, I would like to thank my family and close friends for being everything that a child, teenager, young adult, and soon to be Ph.D. graduate could ever need. I owe you a lifetime of gratitude for the lifetime of unwavering love and support you have given me. Through my worst, my best, my hardest, and my proudest, you have stood by my side and reminded me that the next great thing ahead is real and possible. Thank you for being here, always.

Lastly, I would like to thank my partner Colleen. We met in the middle of my doctorate adventure, but in many ways, that was when my real adventure began. I thank you endlessly for all the things that you know you have done to make this dissertation a reality. However, I also want to thank you for what you may not know you do. You are the strongest, smartest, and most driven person I know, and it is impossible to be around you and not be fired up to try and match your greatness. You are my biggest hero, my role model, and my motivation. Thank you for being both the light at the end of the tunnel and the force that propelled me through it.

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ABSTRACT OF THE DISSERTATION

Sleep in College Club Athletes:

Patterns, Correlates, and Comparisons with College Non-Athletes

By

Dmitry Tsukerman

Doctor of Philosophy in Psychological Science

University of California, Irvine, 2020

Professor Susan Charles, Co-Chair

Associate Professor Angela Lukowski, Co-Chair

Sufficient sleep is essential for maintaining physical and emotional well-being, and both quantity and quality of sleep are related to numerous well-being and functional outcomes. Among college students, poor sleep has been related to poorer mental health and academic performance. Collegiate athletes are a subgroup of college students that may face additional challenges in maintaining ample and good quality sleep due to the time demands, psychological pressures, and rigid schedules associated with participation in college sports. Sleeping well may be even more critical for college athletes relative to the general undergraduate population, as the success of college athletes on the field may greatly rely on the restorative benefits of sleep to both their physical and psychological functioning. However, no known studies have examined sleep or well-being outcomes in college club athletes, who compete at a lower level than NCAA-level athletes but may still experience many of the same stressors and sleep problems.

In two studies, the present dissertation examined both objective (i.e., wrist actigraphy) and subjective sleep parameters and their correlates in college club athletes (Study 1) and compared subjective sleep variables and academic performance between college club athletes and college non-athletes (Study 2). Club athletes and non-athletes did not differ in their sleep profiles or academic performance, but club athletes reported feeling less stressed than non-athletes. For club athletes, important relationships were found between both objective and subjective sleep measures and next day affect. Notably, athletes reported lower negative affect on days after which they had above average sleep efficiency and self-reported sleep quality the previous night, as well as higher positive affect after nights of better self-reported sleep. Additionally, for club athletes, better sleep hygiene was related to both higher daily and global subjective sleep quality and to lower reported insomnia severity. Sleep profiles of college club athletes are discussed in comparison to previous findings for college students, college athletes, and elite athletes. Implications for the affective and functional consequences of poor sleep in club athletes are also discussed.

Introduction

Most people can readily recall having experienced difficulties in daytime functioning after a night of poor or little sleep. After such nights, people may wake up feeling groggy, have difficulty concentrating, and may feel more stressed, moody, and irritable than usual. Sleep problems in America have become a public health crisis in recent years, with between 50-70 million adults reporting having chronic sleep problems (Centers for Disease Control and Prevention, 2009). Americans increasingly obtain insufficient amounts of sleep and continue to report poor sleep quality (Barnes & Drake, 2015; National Sleep Foundation, 2015; Strine & Chapman, 2005). The National Sleep Foundation has updated their sleep recommendations for adults aged 18-64 to between 7-9 hours of sleep nightly (Hirshkowitz, Whiton, Albert, Alessi, Bruni, DonCarlos, et al., 2015), yet approximately 35% of U.S. adults report sleeping fewer than 7 hours per night (Centers for Disease Control and Prevention, 2014). Moreover, both poor quality and insufficient sleep are associated with numerous adverse mental health outcomes (Pilcher et al., 1997; Vandekerckhove & Cluydts, 2010).

Sleep Measurement

Sleep has been conceptualized and measured in various ways across the literature. Typically, sleep is discussed in terms of quantity and quality, and studies have demonstrated different associations of each with well-being outcomes (e.g., Pilcher et al., 1997). Whereas sleep quantity (duration) is a more straight-forward construct (total sleep time per night), sleep quality varies widely in its definitions (Krystal & Edinger, 2008). The most common indicators of good versus poor sleep quality in the literature are sleep onset latency (the time it takes one to fall asleep), number of nighttime awakenings, time awake after sleep onset (WASO), sleep efficiency (percentage of total time in bed that is spent asleep), and next day feelings of

restfulness (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Girschik, Fritschi, Heyworth, & Waters, 2012; Ohayon et al., 2017; Pilcher et al., 1997). In 2017, the National Sleep Foundation gathered a team of sleep experts to systematically review the literature on sleep quality and compile a list of consensus recommendations for sleep quality indicators and the cut-off values for each (Ohayon et al., 2017). The following agreed-upon indicators and values were reported: sleep onset latency of 30 minutes or less, no more than one nighttime awakening lasting longer than 5 minutes, less than 20 total minutes of awake time after sleep onset, and a sleep efficiency of 85% or higher.

Sleep quality and duration may be assessed through objective measures using different electronic devices, or subjectively through self-report, where participants reflect on how they slept over the previous night, week, or month. Polysomnography (PSG) is considered the "gold standard" of objective sleep measurement (Marino et al., 2013). In this laboratory method, participants are fitted with multiple electrodes that capture a number of physiological parameters including electroencephalography (EEG; brain activity), eye movement, and muscle, heart, and respiratory activity. Polysomnography yields comprehensive sleep data, yet this technique requires trained technicians, multiple nights (typically) spent in a sleep laboratory, and is often too costly and impractical for widespread research use (Mantua, Gravel, & Spencer, 2016; Marino et al., 2013). A more practical, relatively inexpensive, and well-validated objective sleep measurement alternative to PSG is wrist actigraphy (Aili, Åström-Paulsson, Stoetzer, Svartengren, & Hillert, 2017; Mantua et al., 2016; Sadeh, Hauri, Kripke, & Lavie, 1995; Van De Water, Holmes, & Hurley, 2011).

Wrist actigraphy measurement involves a wrist-worn device roughly the size of a wrist watch that captures participants' movements and translates them into numerical data using set

algorithms pre-programmed into commercially-available data reduction computer software (Martin & Hakim, 2011). Aside from its affordability relative to PSG, another advantage of wrist actigraphy is its ability to capture multiple sleep parameters (e.g., sleep duration, onset latency, nighttime awakenings/wake time after sleep onset, and sleep efficiency) across multiple days in the participants' natural environment (Martin & Hakim, 2011; Van De Water et al., 2011). Wrist actigraphy has been validated against PSG across multiple studies and is widely accepted as a useful and ecologically valid measure of sleep for research (Marino et al., 2013; Martin & Hakim, 2011; Sadeh et al., 1995). However, one limitation of wrist actigraphy is that it can overestimate sleep time during periods when a participant is actually awake but exhibiting little bodily movement (Marino et al., 2013; Martin & Hakim, 2011; Van De Water et al., 2011). To remedy this, researchers recommend the supplementary usage of sleep diaries against which the actigraphy-recorded data can be validated (Marino et al., 2013; Martin & Hakim, 2011).

Although objective measures of sleep yield greater precision, subjective (i.e., self-report) measures remain common in sleep research as quick and low-resource alternatives (Jackowska, Ronaldson, Brown, & Steptoe, 2016). One method of assessing sleep duration is to simply ask participants to estimate how many hours they slept during the previous night or set of nights (Lauderdale, 2008). Likewise, sleep quality can be assessed with individual questions that ask for overall judgments of previous-night or general sleep quality or how a participant feels in the morning (e.g., Girschik et al., 2012). Another approach to subjective sleep measurement is to use multi-item scales that assess and provide scores for multiple sleep parameters in either a daily diary (e.g., Karolinska Sleep Diary; Akerstedt, Hume, Minors, & Waterhouse, 1994) or a longer-term retrospective (e.g., past month; Pittsburgh Sleep Quality Index or PSQI; Buysse et al., 1989) format.

Sleep in College Students

College students represent a subsample of Americans that is particularly prone to unhealthy sleep habits and poor and inconsistent sleep (Centers for Disease Control and Prevention, 2014). There are many reasons why college students may obtain such poor sleep. College represents a major life transition for many students that includes significant changes to daily schedules and routines, increased independence and freedom to make decisions regarding their behavior and health practices, and new emotional and psychological challenges. Together, these changes can make it challenging for university students to maintain good sleep hygiene and attain good quality sleep (Lund, Reider, Whiting, & Prichard, 2010; Orzech, Salafsky, & Hamilton, 2011).

The general patterns of sleep problems in college students are fairly consistent across the literature; college students get less sleep than non-college aged adults, report worse sleep quality, and have less consistent sleep schedules (Buboltz, Brown, & Soper, 2001; Gaultney, 2010; Lund et al., 2010; Orzech et al., 2011). Corren (1994) examined the rates of sleep disruption in a sample of 2,700 young adults aged 17-30 from the community as well as from college campuses. Nearly one-third of this sample reported frequent experiences of symptoms of sleep disruption, including early awakening and morning fatigue. Overall, approximately two-thirds of the sample reported at least one weekly experience of these symptoms, with morning fatigue being the most common. In another study of 1,800 university students, 27% were reported to be at high risk for a sleep disorder (Gaultney, 2010). Students from this sample also reported sleeping an average of 6.79 hours on weeknights, which is below the recommended 7-9 for this age group (Hirshkowitz et al., 2015). They also showed a large discrepancy between weeknight and weekend sleep duration, indicative of inconsistent sleep schedules (Gaultney, 2010). A recent

large multi-university study of over 7,600 college students found that more than a quarter of the sample reported poor sleep quality, one-third reported getting fewer than seven hours of sleep per night, nearly half of the sample reported at least one night per week when it takes longer than 30 minutes to fall asleep, and 60% of the sample met PSQI criteria for poor sleep (Becker et al., 2018).

Poor sleep hygiene is believed to significantly contribute to sleep problems in the college student population (Buboltz et al., 2001; Hershner & Chervin, 2014). Sleep hygiene involves a set of behaviors that increase the likelihood of getting good quality sleep. The National Sleep Foundation (2018) recommends the following good sleep hygiene behaviors: limiting duration of daytime naps to less than 30 minutes, avoiding caffeine and nicotine before bedtime, exercising (but not before bedtime), limiting intake of heavy food before bedtime, and limiting exposure to noise and artificial light (especially from television and cell phone screens) at bedtime. Previous research has identified inconsistent sleep schedules (Brown, Buboltz, & Soper, 2002; Buboltz et al., 2001), worry and stress before bed (Brown et al., 2002; Lund et al., 2010), and noisy bedtime conditions (Brown et al., 2002) as predictors of worse sleep outcomes in college students. In a more recent study, over half of one college student sample reported poor sleep hygiene behaviors including strenuous exercise before bed, worrying about sleep, sleeping in noisy environments, and having inconsistent sleep schedules (Felix, Campsen, White, & Buboltz, 2017). Of this same sample, 40-50% of students also reported difficulties going to sleep, staying asleep, and waking up in the morning.

Sleep in College Athletes

Surprisingly, there is a dearth of literature on the patterns, correlates, or consequences of sleep in college athletes, despite the more abundant literature on sleep in the general population

of college students. According to the National Collegiate Athletic Association (NCAA), the governing body that oversees 4-year college athletics, approximately 480,000 college athletes currently compete at the national level (NCAA, 2018). Athletes competing in college-level sports are a distinct sub-group of the college student body, having both shared and unique stressors from non-athletes that affect their sleep and well-being. The little existing literature on sleep in college athletes does suggest that they often get poor and insufficient sleep (Mah, Kezirian, Marcello, & Dement, 2018; Penn Schoen Berland, 2015; Wilson & Pritchard, 2005) and that their sleep tends to be worse during the athletic season (Sexton-Radek, Hernandez, & Pauley, 2013). There are, however, promising studies that suggest increasing sleep time in college athletes may significantly improve their mood and physical performance.

In a survey of over 400 college-athletes across multiple large and athletically-competitive universities, 71% of athletes reported sleep as the number one factor negatively affected by the time constraints of their schedules (Penn Schoen Berland, 2015). The students further believed that insufficient sleep had negatively affected their athletics and academics. Additionally, 77% of student-athletes believed that they get less sleep than college non-athletes and many athletes report habitual 5:00 A.M. wake-up times for training followed by late evenings catching up on homework. In another study, college-athletes reported higher levels of stress about not getting enough sleep than did non-athletes (Wilson & Pritchard, 2005). Sexton-Radek and colleagues (2013) also examined a small sample of college-athletes who completed sleep logs during the active athletic season and during the offseason. Most athletes reported experiencing daytime sleepiness as well as worse sleep efficiency during the active season than in the offseason. Conversely, only one study found that college-athletes report getting more nights of restful sleep

than non-athletes, but poorer sleepers were still more likely to report more depressive symptoms, worse self-esteem, and less social connectedness. (Armstrong & Oomen-Early, 2009).

A recent study is the first known to examine multiple sleep parameters across a large sample of college athletes from many different sports, where sleep was exclusively measured by self-report (Mah et al., 2018). Over 600 male and female varsity athletes across 29 different sports at a large competitive west coast university were surveyed. Overall, 42% of athletes were classified as poor sleepers on the PSQI (Buysse et al., 1989) and 51% had clinically significant daytime sleepiness scores. Further, 39% of athletes reported getting less than seven hours of sleep on weeknights. Athletes reported that noise and temperature were primary external factors interfering with their sleep at night and that overall, they sleep better when traveling for competition than at home (which may be attributed to the disruptive sleeping conditions in the dormitories in which nearly all athletes reside). Another large study of over 900 Japanese college athletes found the following factors as significant predictors of poor sleep scores on the PSQI: early wake-up times and morning practices, psychological distress, late-night cell phone usage, and negative attitudes toward practice and competition (Monma et al., 2018).

Sleep and Emotion

The critical role that sleep plays in emotional functioning (Minkel & Phillips, 2015) is a major reason why the poor sleep patterns consistently observed in college students and athletes are troublesome and have major implications for their well-being (Minkel & Phillips, 2015). Poor sleep is related to reduced feelings of self-esteem (Wong et al., 2013) and increased negative feelings such as anger and confusion (Pilcher et al., 1997), difficulty regulating stress and negative emotions (Palmer & Alfano, 2017), and an increased risk for anxiety and depressive symptoms (Pilcher et al., 1997). Sleep is related to nearly all aspects of our emotional

experience including our physiological reactivity and how emotions are interpreted and processed (Minkel & Phillips, 2015). In fact, research generally supports a bi-directional relationship between sleep and emotional functioning (Vandekerckhove & Cluydts, 2010; Walker & Harvey, 2010). The experience of negative emotions such as anxiety, depressive mood, or feelings of distress during the day can make it difficult to fall asleep and to sleep soundly through the night (Deliens, Gilson, & Peigneux, 2014), and emotional distress is implicated as a cause of multiple sleep disorders (Vandekerckhove, Weiss, Schotte, Exadaktylos, & Haex, 2011). Likewise, after a night of poor sleep, people may be more negatively reactive to stress and be more likely to experience negative emotions (Deliens et al., 2014).

The effects of sleep on emotional functioning. Insufficient sleep can negatively impact self-reported emotional experiences. In one study, Minkel et al. (2014) compared emotional responses to stressors between healthy adults who were either sleep-deprived or sleeping as usual. The sleep-deprived adults reported greater levels of stress, anger, and anxiety when presented with only a mild stressor. Another study utilized actigraphy-measured sleep in conjunction with experience sampling to capture medical residents' emotional responses to either goal-disruptive or goal-enhancing daily events over a 6-month period (Zohar, Tzischinsky, Epstein, & Lavie, 2005). Sleep loss was associated with both greater negative affect (NA) following goal-disruptive events and reduced positive affect (PA) after goal-enhancing events. Findings suggest that sleep loss may exaggerate negative emotional responses while attenuating positive ones. Similarly, sleep is believed to affect how people process emotional information, and sleep deprivation may direct our attention toward negative versus positive information in our environments (Gujar, Mcdonald, Nishida, & Walker, 2011). Overall, these studies show that

sleep may significantly affect both the valence and the magnitude of our emotional responses to stress.

The effects of stress on sleep. Whereas poor sleep has been shown to affect the way people respond to stressful situations the following day (Meerlo et al., 2008; Minkel et al., 2014; Yoo et al., 2007), there are also theoretical mechanisms posited in the reverse direction, such that stress is thought to hinder nighttime sleep. Experiencing emotional stress during the day is associated with delayed sleep onset, altered patterns of both slow wave sleep and rapid eye-movement (REM) sleep, as well as increased nighttime arousal and disrupted sleep patterns (Talamini, Bringmann, Boer, & Hofman, 2013; Vandekerckhove & Cluydts, 2010). Vandekerckhove et al. (2011) used PSG to study the effects of a distressing evening task on nighttime sleep across four nights in a sleep laboratory. Participants experienced both a neutral evening as well as an evening with a stressful negative mood induction to contrast their sleep patterns under these conditions. Compared to sleep after the neutral evening, the emotionally stressful evening resulted in lower sleep efficiency, shorter total sleep time, and percentage of REM, as well as more frequent nighttime awakenings and total WASO. Another study examined the relationships between reports of daytime and evening stress/worry and nighttime sleep across three days using portable in-home PSG devices (Akerstedt, Kecklund, & Axelsson, 2007). Sleep parameters were compared between days with lower and with higher reported evening stress/worry. After more stressful evenings, participants had lower sleep efficiency, greater wake time, and longer latency to deep sleep.

Sleep, Well-Being, and Academic Performance in College Students

Considering the known emotional, psychological, and functional correlates of poor sleep, it is unsurprising that sleep problems experienced by university students are associated with

significant deficits in functioning. Several studies found that poor quality and insufficient sleep was related to greater symptoms of psychological distress (e.g., anxiety, depression), greater subjective experiences of stress, and lower grade point averages (GPAs) in college students (e.g., Lund et al., 2010; Orzech et al., 2011). Becker and colleagues (2018) examined multiple sleep variables in relation to mental health outcomes in a large multi-campus sample of college students. In this study, greater anxious and depressive symptoms were associated with poorer sleep quality and efficiency, longer sleep latency, and shorter sleep duration. Another study found that sleep quality was a stronger predictor of well-being in college students than was sleep duration (Pilcher et al., 1997). In addition, poorer sleep quality was related to greater reported feelings of anxiety, depression, fatigue, and confusion, as well as to lower life satisfaction and PA. Milojevich and Lukowski (2016) likewise found that poorer global sleep quality was positively related to multiple symptoms of psychological distress in a college sample.

Sleep patterns and quality were also related to academic performance in college students. Gilbert and Weaver (2010) found that poorer overall self-rated sleep quality was associated with lower college GPAs. Another large national study of over 54,000 college students found that better subjective sleep quality was associated with better academic performance (Becker, Adams, Orr, & Quilter, 2008). Other studies examining sleep-wake patterns found that earlier bed times (Eliasson, Lettieri, & Eliasson, 2010) and earlier wake times (Eliasson et al., 2010; Trockel, Barnes, & Egget, 2000) were also associated with better academic performance.

Given that the literature supports a reciprocal relationship between stress and sleep (e.g., Vandekerckhove & Cluydts, 2010), college students are particularly likely to be caught in a vicious cycle where their daily stress disrupts their sleep, and consequentially, their poor sleep leads to greater experiences of stress and to difficulties in coping effectively. Multiple studies

have found that stress and worry are significant predictors of poor sleep in college students (Brown et al., 2002; Lund et al., 2010; Verlander, Benedict, & Hanson, 1999), and emotional stress has been linked to longer sleep latency, self-reported shallower sleep, difficulties awakening, and worse quality sleep in college students (Verlander et al., 1999). Likewise, another study of college students found that 24% of the variance in sleep quality was accounted for by measures of psychological stress and tension (Lund et al., 2010).

Sleep, Stress, and Well-Being in College Athletes

Although the student-athlete population reflects a diverse group of individuals, these individuals may share common experiences that may have important implications for their well-being and academic success. In addition to the typical responsibilities and stressors associated with the transition to college life, student-athletes must also manage the challenges of balancing academics with their rigid training and competition schedules, pressure to maintain peak physical health and performance, and manage the fatigue, pain, and injury associated with high-level competition (Armstrong, Burcin, Bjerke, & Early, 2015; Cosh & Tully, 2015; Simons, Rheenen, & Covington, 1999). In addition, college athletes often sacrifice getting enough sleep to accommodate both their early training schedules and their post-training/game academic preparations and assignments (Cosh & Tully, 2015; Wilson & Pritchard, 2005).

Stress and academic performance in college athletes. The Pacific-12 (Pac-12) athletic conference, one of the largest and most competitive west-coast collegiate athletic conferences, commissioned a survey study through the market research firm Penn Schoen Berland (2015) to understand how student-athletes across its member schools view their time demands and the consequences of these demands for their college experience. Over 400 athletes reported spending an average of 50 hours per week on athletics activities during their sport's season, 21

hours of which were directly spent on mandatory athletic activities, and another 29 hours that were spent on related activities including voluntary workouts or training, receiving physical treatment, and traveling for competition. Many of these athletes reported having to wake up at 5:00 AM for practice and still being awake late at night, needing to complete homework assignments after the day's training activities. These student-athletes also overwhelmingly felt that the time demands of their athletic commitments made it difficult for them to engage in enough academic and social activities, and that the areas in which they consequentially suffered the most were in their academic performance and in their loss of sleep. Although the literature on college student athletes remains thin, other studies have also examined the stressors and important academic and well-being outcomes associated with participation in college athletics, and how these may differ from the experiences of college non-athletes (Kamusoko and Pemberton, 2011; Potuto & O'Hanlon, 2007; Simons et al., 1999; Surujal, van Zyl, & Nolan, 2013).

Most studies find that the time constraints imposed by participation in college athletics are a major source of stress for athletes, which may increase the chances for poor sleep. Potuto and O'Hanlon (2007) surveyed over 900 student-athletes across 18 universities. Over half of participants reported not being able to spend as much time on academics as they would like, and a majority report that their involvement in athletics had negative effects on their academic careers. Another study of over 500 college athletes found that they reported above-average stress levels, largely from the challenges of balancing athletics and academics (Surujlal, van Zyl, & Nolan, 2013). Simons and colleagues (1999) discussed how the fatigue from rigorous training schedules made it difficult to focus on academics in the evening, and that athletes often relegated academics to a lower priority when competing for starting positions on their athletics teams.

Kamusoko and Pemberton (2011) also found that first and second year NCAA athletes showed a significant drop in grade point averages from high school to college, and that even though most athletes were aware of academic assistance services available to them, many chose not to utilize them.

Well-being in college athletes. Aside from the pressure to balance athletics commitments with academic requirements, athletes also experience additional stressors which may threaten their well-being. Cosh and Tully (2015) found that student-athletes report being stressed by the lack of flexibility in their schedules, as well as from financial struggles, frequent fatigue, and scheduling conflicts between their academic commitments and outside activities. Athletes also reported having few coping mechanisms to manage their stress. Armstrong and colleagues (2015) reported that some unique stressors experienced by college-athletes include the physical and psychological demands of practice and competition as well as the high pressure to perform well and remain in peak athletic shape. Another study found that student-athletes reported greater stress in their romantic relationships and with time-management than did non-athletes (Wilson & Pritchard, 2005). Surujlal and colleagues (2013) examined the relationships between stress, coping, and life-satisfaction in a large sample of university athletes. Athletes' stress levels were negatively correlated with life satisfaction, and coping skills aimed at reducing worry were also related to higher reported life-satisfaction. Despite the many stressors associated with participation in college athletics, the literature suggests that when compared to student non-athletes, student athletes seem to report better overall mental health, as higher levels of self-esteem and social connectedness may be effective buffers (Aries, Mccarthy, & Salovey, 2004; Armstrong et al., 2015; Armstrong & Oomen-Early, 2009; Wilson & Pritchard, 2005).

Sleep and athletic performance in college athletes. Several articles also examined the relationships between sleep and performance in college-athletes. Schwartz and Simon (2015) compared the serving accuracy of a small group of college tennis players between a week of regular sleep and a week in which the athletes were directed to sleep at least nine hours per night. During the sleep-extension week, athletes increased their average nightly sleep duration from approximately seven to approximately nine hours. The athletes' tennis serve accuracy improved significantly from the shorter to the longer sleep week, corresponding to self-reports of decreased daytime sleepiness during the longer sleep week. In a similar study, a group of competitive male college basketball players were asked to increase their nightly sleep duration from their baseline of less than seven hours to a minimum of ten hours for the duration of a 5-7 week intervention period (Mah, Mah, Kezirian, & Dement, 2011). At the end of this multi-week sleep extension period, the players showed significant increases in their basketball free-throw shooting percentages as well as in their sprinting and reaction times. Players also reported experiencing decreased daytime sleepiness from the baseline period. Improvements across multiple areas of psychological functioning were also reported including increased self-perceptions of training and competition performance, and increased vigor and decreased fatigue and mood disturbance. Finally, one study examined the effects of a night of sleep deprivation versus normal sleep on anaerobic power and reaction time in college athletes (Taheri & Arabameri, 2012). Only reaction time, but not anaerobic power, was significantly better in the regular sleeping group, suggesting that cognitive factors may be affected most by sleep loss.

Given the important implications of understanding sleep and its correlates in student athletes and the dearth of research studies on sleep in this population, wide gaps remain to be filled in this literature. For example, most studies examining sleep in college athletes used self-

reported sleep measures; combining objective (i.e., actigraphy) with subjective measures of sleep should provide a more comprehensive understanding of sleep in student-athletes. In addition, no known published studies have compared sleep profiles between college athletes and college non-athletes. Finally, the few studies on sleep in student-athletes were all conducted with NCAA-level athletes. No known published studies have examined sleep and its correlates in a different, yet common group of college athletes—those who participate in club-level sports.

Club sports are an alternative to the NCAA-level sports offered at most colleges, where students can represent their school in organized competitions against other local and national colleges. Each club is student-organized, including the appointment of coaches, and is overseen by the university's club sports director. Club sports receive some funding from the university and organize fund-raisers to support additional competition-related costs. The University of California, Irvine (UCI) has 39 different club sports (https://www.campusrec.uci.edu/club/index.asp); approximately 1,700 athletes participate annually. Club athlete participants for this dissertation were recruited from the club sports teams considered to be more highly organized, structured, and competitive by the club sports director. Relative to the athletes from the other club sports, the athletes from the selected sports are more committed to participation, maintain a stricter training and competition schedule, and have highly selective team tryouts, thus better fitting the profile of a college athlete. Therefore, it is important to assess whether college club athletes experience sleep problems that are similar to other college athletes, as the findings may have significant implications for their well-being and academic achievement.

Because previous research has not examined sleep and its correlates in club athletes and in comparison to non-athlete college students, the two studies included in this dissertation report on the sleep patterns and quality of college club athletes using both objective and subjective measures (Study 1); examine the relationships among sleep, well-being, and performance in club athletes (Study 1); and compare subjective sleep variables and academic performance between college club athletes and non-athletes (Study 2).

The present studies assess sleep using both subjective and objective measures as previous research suggests that subjective and objective measures of sleep quality may capture different aspects of sleep (Aili et al., 2017; Jackowska et al., 2016; Krystal & Edinger, 2008). First, subjective measures of sleep correlate only modestly with objective sleep measures (Aili et al., 2017; Girschik et al., 2012; Jackowska et al., 2016; Lauderdale, 2008; Matthews et al., 2018). Second, previous research has indicated that measures of subjective sleep quality (i.e., PSQI) had much stronger relationships with multiple subjective well-being outcomes (e.g., optimism, life satisfaction, PA) than did objective measures (i.e., wrist actigraphy; Jackowska et al., 2016). In addition, Tworoger and colleagues (2005) also found that poorer subjective sleep quality, but not actigraphy-measured sleep parameters, was associated with higher self-reported stress.

There are several possible explanations for these discrepancies. Individuals may differ in the criteria by which they judge their own sleep quality (Goelema et al., 2017) and retrospective reports of sleep across a longer time frame (e.g., past month) may also capture more general sleep patterns than objective measures that sample a specific and brief time period (Buysse et al., 2008). The stronger observed relationships of subjective vs objective sleep with mental health outcomes may also be explained by the possibility that subjective mood states bias one's retrospective sleep appraisals (Krystal & Edinger, 2008; Tworoger et al., 2005). Lastly, these

discrepancies may be due to a measurement bias where subjective measures (e.g., self-rated sleep and mood) may naturally be more aligned with one another than would be a subjective and an objective measure (e.g., actigraphy-measured sleep and self-reported mood; Goelema et al., 2017). Therefore, incorporating both subjective and objective measures of sleep in the proposed studies may provide a more complete picture of sleep and its correlates.

Study 1

Research Design and Hypotheses

This study was designed to advance our limited knowledge of the sleep patterns and quality of college club athletes and to document relationships among sleep, well-being, and self-rated performance in college club athletes. Club athletes attended an initial lab session on a Tuesday, at which time they completed several computerized surveys and were fitted with a wrist actigraph (i.e., an objective sleep monitor). Participants were given instructions for using the monitor and for completing daily sleep logs for the duration of the study. The club athletes were asked to wear the actigraph for six consecutive nights (Tuesday through Sunday). Each morning after having worn the monitor during the previous night, the club athletes were asked to complete a brief online questionnaire assessing subjective sleep and mood. Participants returned for a final session on Monday. At that time, they returned the monitor and completed additional questionnaires that assessed psychosocial variables.

Study 1 Aims

Aim 1: The first study aim is to report on the sleep patterns and quality of club athletes using both objective and subjective sleep indicators. This aim is purely descriptive and, as such, there are no associated hypotheses.

Aim 2: The second aim is to examine how sleep relates to the well-being, self-rated athletic performance, and academic achievement (i.e., GPA) in club athletes. I hypothesized that poorer objective (i.e., sleep efficiency, sleep duration, WASO) and subjective sleep (i.e., average daily subjective sleep quality, average global sleep quality, insomnia severity) will be related to poorer subjective well-being (i.e., perceived stress, NA, PA, and athletic coping) and to poorer performance (i.e., self-rated athletic performance and GPA). Poorer sleep hygiene will also be related to poorer objective and subjective sleep.

Aim 3: The third and final aim of Study 1 is to examine fluctuations in daily PA and NA in relation to objective and subjective sleep recorded the previous night. I predict that club athletes will report less NA and more PA following nights on which they reported longer sleep duration, higher sleep efficiency, less WASO, and higher reported sleep quality.

Power Analysis

In a previous study examining associations between sleep variables and measures of well-being (Jackowska et al., 2016), medium to large effect sizes were found for relationships between subjective sleep and well-being (effects ranged from .28-.44) whereas smaller effects were found for objective sleep and well-being (effects ranged from .01-.19). Therefore, to determine the necessary sample size for the proposed study, a power analysis was conducted using a medium effect size of .30. The power analysis was conducted using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) with an alpha level of .05 and a power level of .80. The program suggested a sample size of 84, which was the target sample size of club athletes for this study. Due to challenges recruiting this sample of participants, the final sample size was a bit smaller than expected, including 70 college club athletes (as will be described). The final sample size of 70 resulted in a power of .70 for a medium effect for the correlational analyses in this

study. However, the analyses involving multilevel models were deemed to be sufficiently powered when considering the large number of observations associated with these repeated-measures, within-person analyses.

Method

Participants

Participants included 70 students (67 undergraduates and 3 graduates) who were competitive athletes on various UC Irvine club teams. Participants were 20 years old on average (M = 20.4, SD = 1.9) and 56% were female (see Table 1 for complete descriptive statistics). For this study, male club athletes were recruited from lacrosse, rowing, rugby, and soccer; female athletes were recruited from lacrosse, rowing, rugby, soccer, and water polo. Research assistants attended club team practices, explained the details of the study, and individually recruited the athletes to sign up for available time slots. All club athletes participated during Winter 2018 and Spring 2019 and were in the active season for their respective sports. Athletes received $40 in cash after completing all phases of the study and were also offered a personalized sleep report based on the objective sleep measurements compiled from their actigraphy data.

Materials and Measures

Participants completed online questionnaire batteries that included the following inventories. Published questionnaires were scored as recommended in prior research or in their administration manuals; the other questionnaires were scored as described below. Unless indicated otherwise in the published scoring procedures, missing data were replaced with the mean of the other items in that questionnaire if the participant completed at least 90% of the items; scores were not computed if less than 90% of the items were completed. Items from the

measures listed below can be found in the appendices, however, the formatting was slightly modified for online administration.

Global Measures

Demographic questionnaire. The demographic questionnaire assessed age, ethnicity, gender, year in school, medication taken for mood or for sleep problems, the presence of a diagnosed sleep condition, average number of hours of exercise completed per week as well as total hours of sports-related activity, and GPA.

Global sleep quality. The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) is a 19-item scale that assesses sleep habits as well as perceptions of various aspects of the sleep experience over the past month. Considered the gold standard for self-reported sleep quality, the PSQI provides a measure of global sleep quality as well as seven sleep component scores, including sleep duration, subjective sleep quality, sleep latency, sleep efficiency, sleep duration, sleep medication use, and daytime dysfunction. See Appendix A for a full list of items. The seven sleep components are each scored on a scale of 0 to 3 and are summed to produce a global sleep quality score. PSQI global scores greater than 5 indicate categorically poor sleep quality ($\alpha = .46$).

Insomnia severity. The Insomnia Severity Index (Bastien, Vallières, & Morin, 2001) is a 7-item measure of perceived sleep difficulties associated with insomnia as well as the distress associated with experiencing these symptoms over the past two weeks. Sample items include: "Difficulty falling asleep" and "How worried/distressed are you about your current sleep problem?" See Appendix B for a full list of items. Responses were recorded on a scale from 0 to 4. Item scores were summed to yield a composite insomnia severity score with higher values indicating greater insomnia severity ($\alpha = .78$).

Sleep hygiene. The Sleep Hygiene Index (Mastin, Bryson, & Corwyn, 2006) is a 13-item scale that assesses participants' habitual sleep hygiene behaviors. Items are presented on a scale from 0 (never) to 4 (always). Sample items include "I go to bed at different times from day to day" and "I go to bed feeling stressed, angry, upset, or nervous." See Appendix C for a full list of items. Responses to the individual items were summed to yield a total sleep hygiene score; higher scores represent poorer sleep hygiene ($\alpha = .66$).

Athletic coping. The Athletic Coping Skills Inventory-28 (ACSI-28; Smith, Schutz, Smoll, & Ptacek, 1995) is a 28-item measure of athletes' psychological coping resources. Participants are given a list of statements and are asked to indicate how frequently they experienced each item in general on a scale ranging from 0 (almost never) to 3 (almost always). Sample items include: "I get the most out of my talent and skill" and "I remain positive and enthusiastic during competition, no matter how badly things are going." See Appendix D for a full list of items. A total athletic coping composite score was calculated by summing scores for the 28 items; higher scores reflect better coping ($\alpha = .87$).

Stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) is a 10-item measure of self-rated stress. As published, participants are asked to rate how frequently they experienced each item during the past month on a 5-point scale ranging from 0 (never) to 4 (very often). For this study, a modified version of the PSS was used, such that participants were asked to consider each item over the past week instead of the past month to correspond with the time frame of objective and subjective sleep measurements. Sample items include "How often have you felt that things were going your way" and "How often have you been angered because of things that were outside of your control?" See Appendix E for a full list of items. Scores

across the 10 items were summed to yield a composite score, with higher scores indicating greater distress ($\alpha = .87$).

Self-rated athletic performance. Because I was unable to locate an established measure of subjective athletic performance that was appropriate for a week-long time frame and that captured an athlete's global self-ratings of their performance, a 3-item measure of self-rated athletic performance was developed for this study. To construct this scale, one item was adapted from Bray and Martin (2003), one item was adapted from Riemer and Chelladurai (1998), and a third was created for this study. The item adapted from Bray and Martin (2003) assessed coaches' ratings of athletes' skiing performances compared to how the coach thought the athletes usually performed; this item was adapted to, "How well do you think you performed this week overall compared to how well you perform during an average week?". The item adapted from Riemer and Chelladurai (1998) asked about the degree to which an athlete had reached their performance goals during the season. Because the club athletes in this study were tested during different parts of the season, the item was modified to read, "Please indicate the extent to which you believe you met your performance goals this week." The third item created for this study asked, "How satisfied are you overall with your performance this week?". Participants were asked to rate each item on a 5-point scale ranging from 1 to 5, with higher values indicating better self-rated performance. The total scale score was computed as the mean of the three items ($\alpha = .88$).

Daily Measures

Subjective sleep quality. The Karolinska Sleep Diary (Akerstedt et al., 1994) is a 13-item scale on which participants reflect on various aspects of their sleep patterns and subjective sleep quality from the previous night. Participants responded to seven items that assessed

components of subjective sleep quality on a scale of 1 to 5. Per the original author recommendations, 4 of the 7 items were summed to construct a composite sleep quality score. Sample items include "How did you sleep?" and "Did you sleep soundly?". See Appendix F for a full list of items (items in bold were included in the composite sleep quality score). A composite sleep quality score was calculated for each night and nightly scores were averaged to create a weekly mean sleep quality score. In contrast to the PSQI (Buysse et al., 1989), the Karolinska scale provided for a day-to-day assessment of sleep quality that corresponded to the same time period as the several measures of well-being used in the study. Higher values indicate better subjective sleep quality (αs across 6 nights ranged from .71-.78).

Positive and negative mood. The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item scale that assesses current subjective positive and negative mood, with 10 items included on each subscale. Participants indicated the extent to which they experienced each mood item at the time they completed the questionnaire on a scale from 1 (very slightly or not at all) to 5 (extremely). Sample positive items include "excited" and "interested;" sample negative items include "distressed" and "nervous." See Appendix G for a full list of items. Responses to the positive and negative items were separately summed to form PA and NA composite scales, with higher scores indicating more intense feelings on each dimension. In this study, the PANAS was administered as one of the diary surveys to be completed daily upon waking. As such, mean weekly PA and NA scores were also calculated (αs across 6 morning ranged from .91-.96 for PA and from .75-.82 for NA).

Objective sleep parameters. Objective sleep quality and sleep duration were assessed using an Actigraph Mini-Motionlogger (Ambulatory Monitoring, Inc., Ardsley NY) wrist-actigraphy monitor. Wrist actigraphs are small electronic devices that record bodily motion and

translate this motion into numerical data using preset algorithms (Martin & Hakim, 2011). In this study, sleep data were collected in 60-second epochs. The data were reduced using the Sadeh algorithm (Sadeh, Sharkey, & Carskadon, 1994) available in the ActiLife 6 software package (ActiGraph, Pensacola, FL). Three primary sleep parameters were derived for use in this study, including sleep duration (i.e., the total duration of time spent asleep), sleep efficiency (i.e., the percent of time in bed that was spent asleep), and WASO (the total duration of time spent awake after falling asleep). For each sleep parameter, the scores derived from each of the six nights of sleep were also averaged to produce mean weekly objective sleep scores as has been done in previous studies (e.g., Girschik et al., 2012). Higher scores on the three objective sleep parameters represent greater sleep duration, higher sleep efficiency, and greater WASO.

Procedure

Session 1. Participants came in for their first of two sessions on Tuesdays. During their first session, participants met with a research assistant who provided an overview of the study, the expectations for participation, and the procedures for obtaining their $40 cash incentives upon completion. After providing informed consent, the participants completed several online questionnaires, including a demographic questionnaire, the PSQI (Buysse et al., 1989), the Insomnia Severity Index (Bastien et al., 2001), and the Sleep Hygiene Index (Mastin et al., 2006). After participants completed the questionnaires, the research assistant fitted the participant with a wrist actigraph and gave them detailed instructions for wearing the monitor and for completing the daily sleep log and surveys online. Participants were instructed to wear the monitor continuously for six consecutive nights (Tuesday-Sunday), only removing it to shower or to swim. Participants were also told that they would receive an email every night with a link to complete the daily questionnaires the next morning, and that text message reminders to

complete these surveys would be sent each morning. Each participant was asked to provide an approximate wake-time schedule for the week so that daily sleep log completion text message reminders could be sent.

Each evening, participants were sent an email with the link for completing the daily questionnaires the next morning, including the Karolinska Sleep Diary (Akerstedt et al., 1994) and the PANAS (Watson, Clark, & Tellegen, 1988). Participants were instructed to complete these questionnaires from any computer or smart phone within an hour of waking (or as soon as possible thereafter). Each morning, research assistants sent an initial text message reminder within an hour of the participants' previously-indicated anticipated wake times. Research assistants then monitored the survey completion online and sent an additional text message reminder one hour later if the participants had not yet completed the surveys. No more than two text message reminders were sent per day.

Session 2. Participants returned to the lab the Monday after having worn the monitor for six consecutive weeknights. After a research assistant collected the actigraph, the participant completed several more online questionnaires, including the Perceived Stress Scale (Cohen et al., 1983), the Athletic Coping Skills Inventory (Smith et al., 1995), and the subjective measure of athletic performance. These questionnaires were included to assess functioning during the same time frame as the daily objective (i.e., actigraphy) and subjective (i.e., the Karolina Sleep Diary) sleep assessments. These questionnaires were presented at the second session to allow for the examination of associations between them and the sleep and well-being outcomes that were assessed across the previous week. After these final questionnaires were completed, the research assistant asked the participant if they would like to receive a personalized sleep report. Those participants who wanted the report received a copy through email within three weeks of their

participation. Participants were then thanked for their participation, debriefed, and paid $40 in cash.

Results

Descriptive statistics for club athletes are reported in Table 1. Means and standard deviations for general variables are reported in Table 2 and for daily variables in Table 3. For each of the six nights of actigraphy data collection, 67 were missing no more than one night of actigraphy data and the three remaining participants who were missing two or more nights of data were not included in analyses regarding objective sleep measures. Paired sample *t*-tests were conducted to examine mean differences in objective sleep and affect between weeknights and weekends. Compared to average weeknight reports, on weekends participants slept longer: $t(66) = -4.71$, $p < .001$; had greater WASO: $t(66) = -2.25$, $p < .05$; and had lower reported NA: $t(69) = 2.74$, $p < .01$. Average sleep efficiency and daily subjective sleep quality were not significantly different across weeknights and weekends.

Table 1

Descriptive Statistics for Club Athletes

Variable	Athletes *N = 70* *n* (%)
Gender	
Female	39 (55.7)
Male	31 (44.3)
Race/Ethnicity	
Caucasian	42 (60)
Hispanic	25 (35.7)
Asian	21 (30)
African American	2 (2.9)
American Indian/Alaskan Native	1 (1.4)
Native Hawaiian/Pacific Islander	0
Other	10 (14.3)
Academic Status	
Freshman	7 (10)
Sophomore	22 (31.4)
Junior	11 (15.7)
Senior	27 (38.6)
Graduate	3 (4.3)
Major (School)	
Biological Sciences	9 (12.9)
Business	6 (8.6)
Computer Science	4 (5.7)
Education	1 (1.4)
Engineering	13 (18.6)
Health Science	4 (5.7)
Physical Sciences	9 (12.9)
Social Ecology	11 (15.7)
Social Sciences	6 (8.6)
Undeclared	7 (10)
Club Sport	
Men's	
Lacrosse	2 (2.9)
Rowing	17 (24.3)
Rugby	6 (8.6)
Soccer	6 (8.6)
Women's	
Lacrosse	9 (12.9)
Rowing	12 (17.1)
Rugby	3 (4.3)
Soccer	6 (8.6)
Water Polo	9 (12.9)

Table 2

Means and Standard Deviations of General Variables for Club Athletes

Variables	*M*	*SD*
PSQI global sleep quality	5.52	2.15
Insomnia severity	7.03	4.05
Sleep hygiene	19.99	5.98
Stress	15.67	6.42
Athletic coping	51.38	10.92
Self-rated athletic performance	3.46	.78
GPA	3.13	.53
Exercise total	15.21	5.36

Table 3

Means and Standard Deviations of Daily Variables for Club Athletes

	Weekday		Weekend		Overall	
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*
Self-reported sleep quality	14.69	2.00	15.32	2.85	14.91	1.89
Actigraphy						
Total sleep time (min)	353.00	61.32	399.35	78.65	369.09	56.13
Sleep efficiency (%)	84.14	6.64	84.83	6.26	84.34	6.15
WASO (min)	57.82	26.74	64.25	29.22	60.00	25.29
Negative affect	13.96	3.48	13.12	3.78	13.69	3.37
Positive affect	21.54	7.36	22.29	9.01	21.80	7.52

Hypothesis testing. Bivariate zero-order correlations among all sleep and well-being variables are shown in Table 4. I hypothesized that poorer objective (i.e., sleep efficiency, sleep duration, WASO) and subjective sleep (i.e., average daily subjective sleep quality, average global sleep quality, insomnia severity) would be related to poorer subjective well-being (i.e., perceived stress, NA, PA, and athletic coping) and to poorer performance (i.e., self-rated athletic performance and GPA). Hypotheses regarding subjective sleep measures were partially supported. As predicted, higher average global and average daily subjective sleep quality, as well as lower insomnia severity were related to less reported weekly stress. Higher average daily subjective sleep quality was also related to higher GPAs, and higher insomnia severity was related to worse athletic coping. No additional significant associations were found between subjective sleep variables and well-being or performance. Hypotheses regarding objective sleep measures recorded from the actigraph were unsupported, as objective sleep was unrelated to measures of well-being or performance. I also predicted that poorer sleep hygiene would be related to poorer objective and subjective sleep. This hypothesis was partially supported in that poorer sleep hygiene was related to worse average global and average daily subjective sleep quality, as well as to higher insomnia severity, but was unrelated to any objective sleep measures.

Table 4

Correlation Matrix for Athletes

Variable	1.	2.	3.	4.	5.	6.	7.	8	9.	10.	11.	12.	13.
1. PSQI global score	-	-	-	-	-	-	-	-	-	-	-	-	-
2. S-R sleep quality	-.37**	-	-	-	-	-	-	-	-	-	-	-	-
3. Insomnia severity	.66***	-.31**	-	-	-	-	-	-	-	-	-	-	-
4. Sleep hygiene	.49***	-.27*	.58**	-	-	-	-	-	-	-	-	-	-
5. Sleep duration	-.25	.07	-.20	.00	-	-	-	-	-	-	-	-	-
6. Sleep efficiency	-.28*	.13	-.18	-.06	.54***	-	-	-	-	-	-	-	-
7. WASO	.15	-.09	.09	.02	-.15	-.87***	-	-	-	-	-	-	-
8. Negative affect	.14	-.14	.18	.25*	-.14	-.17	.10	-	-	-	-	-	-
9. Positive affect	-.18	-.05	-.15	-.18	-.15	.00	-.08	.21	-	-	-	-	-
10. Stress	.30*	-.25*	.34**	.37**	.06	-.11	.08	.43***	-.16	-	-	-	-
11. Athletic coping	-.33	.23	-.38**	-.35**	.02	.07	-.12	-.28*	.21	-.42**	-	-	-
12. S-R athletic perf.	-.07	.09	-.15	-.16	-.08	.14	-.18	-.01	.30*	-.40**	.12	-	
13. GPA	-.15	.24*	-.06	.08	-.01	.08	-.10	.06	-.05	-.06	-.07	-.05	-
14. Exercise Total	.13	.15	-.07	-.34**	-.35**	-.18	.09	-.13	.01	-.23*	.10	.19	.03

Note. *$p < .05$; **$p < .01$; S-R sleep quality = Self-rated sleep quality; S-R athletic perf. = Self-rated athletic performance

In additional correlations regarding subjective sleep measures, global subjective sleep quality was related to higher average daily subjective sleep quality, higher sleep efficiency, and to lower insomnia severity. Higher average daily subjective sleep quality was also related to lower insomnia severity. Better sleep hygiene was related to less stress and better athletic coping. Regarding objective sleep variables, greater average sleep duration was significantly related to higher average sleep efficiency and to less average weekly exercise. Higher average sleep efficiency was significantly related to less average WASO; WASO was not related to any other variables. For average daily affect, higher NA was related to poorer sleep hygiene, more stress, and worse athletic coping; higher PA was related to better self-rated athletic performance. There were no significant gender or ethnic differences in any sleep or affect variables.

I hypothesized that participants would report less NA and more PA on days when they had longer sleep duration, higher sleep efficiency, less WASO, and higher reported sleep quality the night before. This hypothesis was tested in two separate two-level multilevel models (MLM; Raudenbush & Byrk, 2002). Model 1 was conducted to examine daily NA, whereas Model 2 examined PA (see Table 5). The first level of each model tested whether within-person variability in daily affect fluctuated in relation to sleep obtained the previous night. The second level tested between-person variability, examining how daily levels of PA and NA were related to average weekly levels of sleep and average levels of affect as well as the covariates age, gender, and ethnicity.

Table 5

Nightly Sleep Variable Differences in Next-Day Negative and Positive Affect

Fixed Effects	Model 1 (NA) Estimate (SE)	Model 2 (PA) Estimate (SE)
Intercept	33.62 (22.57)	42.47 (51.50)
Age	.21 (.27)	.01 (.61)
Sex (ref = female)	.77 (.96)	3.76 (2.18)
Ethnicity (ref = mixed/other)		
Caucasian	.63 (1.12)	-4.92 (2.55)
Asian	.62 (1.18)	-1.59 (2.70)
Hispanic	1.58 (1.53)	-.10 (3.51)
Subjective sleep quality (daily)	-.30 (.06)***	.72 (.11)***
Subjective sleep quality (avg)	.11 (.24)	-.84 (.55)
Sleep efficiency (daily)	-.15 (.04)***	.05 (.07)
Sleep efficiency (avg)	-.10 (.26)	-.16 (.60)
Total sleep time (daily)	.01 (.00)***	-.01 (.01)
Total sleep time (avg)	-.01 (.01)	-.01 (.03)
Wake after sleep onset (daily)	-.02 (.01)*	-.01 (.02)
Wake after sleep onset (avg)	-.03 (.05)	-.06 (.12)
Random Effects		
Intercept	9.29 (2.05)***	51.84 (10.76)***
Residual	7.78 (.70)***	25.52 (2.30)***
Model Fit		
AIC	1708.3	2096.1
BIC	1712.7	2100.5

Note. $N = 67$; *$p < .05$; ***$p < .001$.

When considering NA, the results of Model 1 indicated that participants reported higher NA on days when they also reported lower than average sleep quality, had lower than average sleep efficiency, and had less than average WASO the previous night. Participants also reported higher NA on days following higher than average sleep duration. There were no significant level 2 effects,

indicating that NA did not differ across individuals based on their mean levels of sleep or by their age, gender, or ethnicity.

When considering PA, the results of Model 2 indicated that higher than average sleep quality predicted higher levels of PA. No other subjective or objective daily sleep measures were related to daily PA. There were also no significant level 2 effects, indicating that daily levels of PA did not differ across individuals based on their mean levels of sleep or by their age, gender, or ethnicity.

Study 1 Discussion

The first aim of Study 1 was to report on the sleep patterns and quality of college club athletes using both objective and subjective sleep measures. Because this is the first known study to examine sleep and its correlates in college club athletes, the resulting descriptive statistics represent an important contribution to the literature, as they establish a benchmark against which future data can be compared. As mentioned previously, objective sleep data were collected from athletes across six nights using wrist actigraphy. Because sleep data differ on weekdays and weekends in college samples (Tsai & Li, 2004), mean values were reported separately for weekdays and weekends as well as across entire period of data collection. Data on whether or not participants napped throughout the day was not assessed in this study. When considering nighttime sleep duration, club athletes slept an average of 5.88 hours on weeknights, 6.66 hours on weekends, and 6.15 hours across the recording period. A total of 7-9 hours of sleep per night is recommended for college-aged adults (Hirshkowitz et al., 2015). In this study, the participants' average sleep efficiency was 84.14% on weeknights, 84.83% on weekends, and 84.34% across the six nights of testing. An 85% minimum sleep efficiency is the suggested cut-off for good sleep quality in healthy adults (Ohayon et al., 2017). In this study, the participants were awake after sleep onset

approximately 57.82 minutes on weeknights, 64.25 minutes on weekends, and 60.00 minutes across the recording interval. A maximum WASO of 20 minutes is the suggested cut-off for good sleep quality (Ohayon et al., 2017). When considering subjective sleep scores, the average PSQI global sleep quality score in this sample was 5.52; scores exceeding 5 are indicative of categorically poor sleep (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The mean insomnia severity score was 7.03; scores of 8-14 are in the range for sub-clinical insomnia (Bastien et al., 2001). The average sleep hygiene score was 19.99; higher scores are indicative of poorer sleep hygiene, but no suggested cut-offs were found in the literature.

The second aim of the study was to examine the relationships among sleep, well-being, and performance in college club athletes, as they are an understudied population. The two measures of subjective sleep quality (i.e., the Karolinska for daily subjective sleep quality and the PSQI for global sleep quality over the previous month), demonstrated similar relationships with the other included measures of sleep and well-being. That is, both the Karolinska and the PSQI global score were related to lower insomnia severity ratings, better sleep hygiene, and less weekly stress, but only daily subjective sleep quality was related to higher GPA. Sleep hygiene was significantly related to both daily and monthly subjective sleep quality as well as to insomnia severity, suggesting that club athletes with poorer sleep hygiene also experienced poor and disrupted sleep. Poorer sleep hygiene was also associated with higher NA and stress as well as poorer athletic coping, emphasizing the relationship between sleep-related behaviors, athletes' well-being, and their management of sports-related challenges. Interestingly, measures of subjective and objective sleep quality were not related to PA, NA, or self-rated athletic performance. Overall, subjective sleep measures were mostly unrelated to objective sleep measures, except that global sleep quality was related to better sleep efficiency as measured via actigraphy. Findings suggest that different

subjective sleep measures generally demonstrated high concordance with one another, but not with objective sleep measures.

The third aim of this study was to examine fluctuations in daily PA and NA in relation to objective and subjective sleep recorded the previous night. I hypothesized that participants would report less NA and more PA on days when they had longer sleep duration, higher sleep efficiency, less WASO, and higher reported sleep quality the night before. This prediction was partially supported for both dependent measures. That is, participants reported less NA when they had higher than average sleep efficiency and higher self-reported sleep quality the previous night. The findings for sleep duration and WASO were significant, but in the direction opposite of what was predicted. That is, greater nightly sleep duration was related to higher next-day NA whereas greater WASO was associated with lower next-day NA. When considering PA, athletes reported higher PA following nights on which they had reported good quality sleep. However, significant relationships were not found between PA and sleep duration, sleep efficiency, or WASO recorded from the previous night. Conceptual implications of these findings will be discussed in the General Discussion.

Study 2

Research Design and Hypotheses

The purpose of Study 2 was to further our understanding of how sleep and academic performance may differ between college club athletes and college non-athletes. For this study, club athletes were recruited from University of California, Irvine (UCI) club sports teams and college non-athletes were recruited for comparison through the UCI Human Subjects Lab Pool as well as through targeted classroom announcements. Both the athletes and the non-athletes completed

several computerized surveys assessing subjective sleep parameters and academic performance, as well as other psychosocial variables.

Study 2 Aim: The goal of Study 2 was to compare subjective sleep variables and academic performance between college club athletes and non-athletes. When considering subjective sleep quality and sleep quantity in college club athletes versus college non-athletes, I predicted that club athletes would report worse subjective sleep (i.e., lower perceived sleep quality, lower sleep efficiency, and more daily disturbances), poorer reported sleep hygiene, and greater symptoms of insomnia than college non-athletes. When considering subjective sleep and academic performance in college club athletes versus college non-athletes, I expected that poorer global subjective sleep quality would be related to lower cumulative GPAs for participants in both groups; I also expected that club athletes would have lower cumulative GPAs compared to college non-athletes.

Method

Participants

Participants in this study included UCI club athletes ($N = 70$) and UCI non-athletes ($N = 140$). The club athletes were the same participants described in Study 1. Non-athletes were recruited through the UCI Human Subjects Lab Pool (HSLP; $n = 96$) and through classroom announcements ($n = 54$). The non-athlete participants were 20.5 years old on average ($SD = 1.8$) and 63% were female (see Table 6 for complete descriptive statistics).

Participants were recruited using different techniques given the goal of recruiting non-athlete participants from majors endorsed by the club athletes. Because students only participate in research through the HSLP when they are enrolled in eligible psychology courses, students were also broadly recruited through targeted classroom announcements across courses from majors similar to those endorsed by the club athletes. All non-athletes were tested during the Fall 2019 and

Winter 2020 quarters. Non-athletes recruited through the HSLP earned one unit of extra credit that could be applied to an eligible psychology course of their choice; participants recruited through classroom announcements earned $10 in cash for their participation.

Materials and Measures

Participants completed online questionnaire batteries that included the following inventories. Published questionnaires were scored as recommended in prior research or in their administration manuals; the other questionnaires were scored as described below. Unless indicated otherwise in the published scoring procedures, missing data were replaced with the mean of the other items in that questionnaire if the participant completed at least 90% of the items; scores were not computed if less than 90% of the items were completed. Items from the measures listed below can be found in the appendices, however, the formatting was slightly modified for online administration.

Demographic questionnaire. The demographic questionnaire assessed age, ethnicity, gender, year in school, medication taken for mood or for sleep problems, the presence of a diagnosed sleep condition, average number of hours of exercise completed per week as well as total hours of sports-related activity, and GPA.

Global sleep quality. The PSQI (Buysse et al., 1989) is a 19-item scale that assesses sleep habits as well as perceptions of various aspects of the sleep experience over the past month. Considered the gold standard for self-reported sleep quality, the PSQI provides a measure of global sleep quality as well as seven sleep component scores, including sleep duration, subjective sleep quality, sleep latency, sleep efficiency, sleep duration, sleep medication use, and daytime dysfunction. See Appendix A for a full list of items. The seven sleep components are each scored

on a scale of 0 to 3 and are summed to produce a global sleep quality score. PSQI global scores greater than 5 indicate categorically poor sleep quality ($\alpha = .45$).

A three-factor model of PSQI component scores has been supported (Cole et al., 2006), including sleep efficiency (sleep efficiency, sleep duration), perceived sleep quality (subjective sleep quality, sleep latency, sleep medication use), and daily disturbances (sleep disturbances, daytime dysfunction). For this study, these three composite scales were calculated by summing the respective component scores. Only the global sleep quality score and the three composite scales based on Cole and colleagues (2006) were used for analyses in this study; higher values on these scales indicate poorer sleep.

Insomnia. The Insomnia Severity Index (Bastien et al., 2001) is a 7-item measure of perceived sleep difficulties associated with insomnia as well as the distress associated with experiencing these symptoms over the past two weeks. Sample items include "Difficulty falling asleep" and "How worried/distressed are you about your current sleep problem?" See Appendix B for a full list of items. Responses were recorded on a scale from 0 to 4. Item scores were summed to yield a composite insomnia severity score with higher values indicating greater insomnia severity ($\alpha = .80$).

Sleep hygiene. The Sleep Hygiene Index (Mastin et al., 2006) is a 13-item scale that assesses participants' habitual sleep hygiene behaviors. Items are presented on a scale from 0 (never) to 4 (always). Sample items include "I go to bed at different times from day to day" and "I go to bed feeling stressed, angry, upset, or nervous." See Appendix C for a full list of items. Responses to the individual items were summed to yield a total sleep hygiene score; higher scores represent poorer sleep hygiene ($\alpha = .64$).

Stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) is a 10-item measure of self-rated stress. As published, participants are asked to rate how frequently they experienced each item during the past month on a 5-point scale ranging from 0 (never) to 4 (very often). For this study, a modified version of the PSS was used, such that participants were asked to consider each item over the past week instead of the past month to correspond with the time frame of objective and subjective sleep measurements. Sample items include "How often have you felt that things were going your way" and "How often have you been angered because of things that were outside of your control?" See Appendix E for a full list of items. Scores across the 10 items were summed to yield a composite score, with higher scores indicating greater feelings of stress ($\alpha = .88$).

Procedures

Participants came into the laboratory and completed several online questionnaires in the order listed in the Measures section. Club athletes completed these surveys during the first of their two sessions; non-athletes completed them during their one scheduled study session. The surveys took no more than 45 minutes to complete. When they finished with the questionnaires, participants were asked to access their unofficial transcripts online, from which their cumulative GPAs were recorded. After participants completed the questionnaire battery, one unit of credit was assigned to non-athlete students who were recruited through the HSRP; $10 in cash was provided to non-athlete participants recruited through classroom announcements; $40 in cash was provided to club athlete participants at the conclusion of their second session.

Results

Descriptive statistics for club athletes and non-athletes are reported in Table 6 and means and standard deviations for key variables are reported in Table 7. Two-way between-subjects

analyses of variance (ANOVAs) were used to examine mean differences in key variables by athlete status (club athlete or non-athlete), gender (male or female), and their interaction. For average weekly hours of exercise, significant main effects of athlete status: $F(1, 206) = 266.25$, $p < .001$, and gender: $F(1, 206) = 41.09$, $p < .001$, were qualified by an interaction with one another: $F(1, 206) = 9.51$, $p < .05$.

Table 6

Descriptive Statistics for Club Athletes and Non-Athletes.

Variable	Athletes *N = 70*	Non-Athletes *N* = 140
	n (%)	
Gender		
Female	39 (55.7)	89 (63.6)
Male	31 (44.3)	51 (36.4)
Race/Ethnicity		
Caucasian	42 (60)	44 (31.4)
Hispanic	25 (35.7)	39 (27.9)
Asian	21 (30)	75 (53.6)
African American	2 (2.9)	1 (.7)
American Indian/Alaskan Native	1 (1.4)	1 (.7)
Native Hawaiian/Pacific Islander	0	1 (.7)
Other	10 (14.3)	19 (13.6)
Academic Status		
Freshman	7 (10)	15 (10.7)
Sophomore	22 (31.4)	20 (14.3)
Junior	11 (15.7)	53 (37.9)
Senior	27 (38.6)	52 (37.1)
Graduate	3 (4.3)	0
Major (School)		
Biological Sciences	9 (12.9)	9 (6.4)
Business	6 (8.6)	12 (8.6)
Computer Science	4 (5.7)	4 (2.9)
Education	1 (1.4)	8 (5.7)
Engineering	13 (18.6)	6 (4.3)
Health Science	4 (5.7)	4 (2.9)
Physical Sciences	9 (12.9)	1 (.7)
Social Ecology	11 (15.7)	63 (45)
Social Sciences	6 (8.6)	25 (17.9)
Undeclared	7 (10)	3 (2.1)
Club Sport		
Men's		
Lacrosse	2 (2.9)	--
Rowing	17 (24.3)	--
Rugby	6 (8.6)	--
Soccer	6 (8.6)	--
Women's		
Lacrosse	9 (12.9)	--
Rowing	12 (17.1)	--
Rugby	3 (4.3)	--
Soccer	6 (8.6)	--
Water Polo	9 (12.9)	--

Table 7

Means and Standard Deviations of Key Variables for Club Athletes and Non-Athletes

	M (SD)	
Variables	Athletes	Non-Athletes
Insomnia Severity	7.03 (4.05)	7.59 (4.48)
Sleep Hygiene	19.99 (5.98)	21.05 (6.19)
PSQI		
Global Score	5.52 (2.15)	5.76 (2.24)
Sleep Efficiency	.88 (.94)	.98 (1.14)
Perceived Sleep Quality	2.22 (1.12)	2.31 (1.23)
Daily Disturbances	2.41 (.88)	2.47 (.88)
Stress	15.67 (6.42)	19.08 (7.37)
GPA	3.13 (.53)	3.28 (.49)
Exercise Total	15.21 (5.37)	5.68 (3.67)

Follow-up pairwise comparisons revealed that all combinations of athlete status and gender differed significantly from one another (all *p*s < .01). For athletes, males (18.32 ± 5.17) reported more weekly exercise than females (12.74 ± 4.15), with the same pattern for non-athlete males (6.92 ± 4.56) and females (4.97 ± 2.85). For males, athletes (18.32 ± 5.17) reported more weekly exercise than non-athletes (6.92 ± 4.56); the same pattern held for female athletes (12.74 ± 4.15) versus non-athletes (4.97 ± 2.85).

For stress, only a significant main effect for athlete status was found: $F(1, 206) = 9.23$, $p < .01$, such that non-athletes (19.08 ± 7.37) reported more weekly stress than athletes (15.67 ± 16.42). When considering the sleep data, a significant main effect of gender was found for sleep hygiene: $F(1, 206) = 3.95$, $p < .05$, such that males (19.59 ± 5.95) reported better sleep hygiene than females (21.41 ± 6.15). Significant group differences were not found for insomnia severity, PSQI global

sleep quality, or for the PSQI composite scores for sleep efficiency, subjective sleep quality, and daily disturbance.

Bivariate zero-order correlations among all key variables are found in Table 8. Greater insomnia severity was significantly related to poorer sleep hygiene, worse PSQI global sleep quality, poorer PSQI sleep efficiency, poorer PSQI perceived sleep quality, more PSQI daily disturbances, and higher reported stress. Poorer sleep hygiene was related to worse PSQI global sleep quality, poorer PSQI perceived sleep quality, more PSQI daily disturbances, higher reported stress, and to fewer weekly hours of exercise. Exercise was not significantly related to any other variables. Worse PSQI global sleep quality was related to poorer PSQI sleep efficiency, worse PSQI perceived sleep quality, more PSQI daily disturbances, and higher reported stress. Worse PSQI sleep efficiency was related to poorer PSQI perceived sleep quality, more PSQI daily disturbances, and to lower GPA, which was not significantly related to any other variables. Poorer PSQI perceived sleep quality was related to more PSQI daily disturbances, which were also related to higher reported stress.

Table 8

Correlations Among Primary Study Variables for Club Athletes and Non-Athletes

Variable	1.	2.	3.	4.	5.	6.	7.	8.
1.Insomnia severity	-	-	-	-	-	-	-	-
2.Sleep hygiene	.40***	-	-	-	-	-	-	-
3.PSQI global sleep quality	.65***	.26**	-	-	-	-	-	-
4.PSQI sleep efficiency[a]	.34***	.10	.69***	-	-	-	-	-
5.PSQI perceived sleep quality[a]	.51***	.19*	.75***	.21**	-	-	-	-
6.PSQI daily disturbances[a]	.51***	.28***	.65***	.22**	.28**	-	-	-
7.Stress	.45***	.31***	.28***	.15	.13	.33***	-	-
8.GPA	-.12	.13	-.14	-.17*	-.05	-.08	.06	-
9.Exercise (weekly hours)	-.07	-.18*	-.02	.03	-.09	.03	-.28	-.09

Note. *$p < .05$; **$p < .01$; ***$p < .001$; [a] PSQI composite scores; Higher values represent:
greater insomnia severity, worse sleep hygiene, worse global sleep quality, lower sleep efficiency, worse perceived sleep quality, more daily disturbances, and more stress.

Hypothesis testing. Two one-way multivariate analyses of covariance (MANCOVAs) were conducted to examine differences in sleep parameters between athletes and non-athletes (Table 9). The grouping of dependent variables for each MANCOVA model was determined based on conceptual similarities among the included sleep variables (i.e., sleep-related factors in Model 1 and sleep-related dysfunction in Model 2). The first MANCOVA (Model 1) included sleep efficiency, perceived sleep quality, and sleep hygiene. The second MANCOVA (Model 2) included daily disturbances and insomnia severity (the sample size is somewhat smaller for the second MANCOVA relative to the first, as the data from participants who did not fully complete the PSQI were excluded from analysis). The independent variable for both MANCOVAs was athlete status (club athlete versus college non-athlete). Age and average weekly hours of exercise were entered as covariates in both models. For Model 1, there was no difference between club athletes and non-athletes on the combined sleep variables after controlling for age and average weekly hours of exercise: $F(3, 163) = .56$, $p = .26$, Wilks' $\Lambda = .98$, $\eta_p^2 = .02$. Model 2 was also non-significant: $F(2, 164) = .84$, $p = .44$, Wilks' $\Lambda = .99$, $\eta_p^2 = .01$. Due to non-significant MANCOVA omnibus tests, post-hoc analyses were not conducted.

Table 9

MANCOVA Results for Differences in Sleep Variables Between Club Athletes and Non-Athletes

	Model 1		Model 2	
Variables	*F*	*p*	*F*	*p*
Sleep efficiency[a]	1.26	.26		
Sleep hygiene	2.06	.15		
Perceived sleep quality[a]	.35	.55		
Daily disturbances[a]			.84	.36
Insomnia severity			.09	.77

Note. Athletes $n = 58$; Non-athletes $n = 111$; [a] PSQI composite scores.
Age and weekly hours of exercise were entered as covariates for both models.

A multiple regression analysis was conducted to test whether groups differed in GPAs and whether these differences were moderated by global sleep quality (Table 10). In this model, GPA was the dependent variable; the following variables were entered in order as predictors: covariates (gender, age, ethnicity, hours of exercise), global sleep quality, athlete status (club athlete/non-athlete), and the Athlete Status x Sleep Quality interaction. The overall model was non-significant: $F(9, 141) = 1.62$, $p = .11$, but Hispanic participants (2.98 ± .58) had significantly lower GPAs than Caucasian (3.36 ± .45) and Asian (3.27 ± .47) participants.

Table 10

Regression of GPA on Subjective Sleep and Club Athlete Status

Variables	*b* (*SE*)	95% CI	*β*
Gender	.04 (.09)	[-.14, .22]	.04
Age	.00 (.03)	[-.06, .05]	-.01
Ethnicity[†]			
Caucasian	.42 (.15)	[.13, .72]	.36**
Asian	.26 (.13)	[.00, .51]	.26*
Mixed/other	.18 (.14)	[-.10, .46]	.15
Exercise (weekly)	.00 (.01)	[-.02, .02]	-.01
PSQI Global	-.04 (.07)	[-.16, .09]	-.16
Group	.16 (.12)	[-.08, .40]	.16
Group x PSQI Global	.01 (.04)	[-.07, .08]	.06
R^2		.09	

Note. *Group* = Club athlete vs. non-athlete.
*$p < .05$; **$p < .01$. $N = 151$. [†]Hispanic = reference group.

Study 2 Discussion

The aim of Study 2 was to compare subjective sleep variables and academic performance between college club athletes and college non-athletes. Relative to college non-athletes, I hypothesized that club athletes will have worse subjective sleep (i.e., lower perceived sleep quality, lower sleep efficiency, and more daily disturbances), poorer reported sleep hygiene, and more reported symptoms of insomnia than college non-athletes. Hypothesis testing produced null findings for all sleep comparisons. In the MANCOVA model testing associations between athlete status and sleep-related factors, differences were not found between club athletes and non-athletes for the combined dependent variables of sleep efficiency, sleep hygiene, and perceived sleep quality. In the MANCOVA model testing associations between athlete status and sleep-related dysfunction, differences were similarly not observed between athletes and non-

athletes for the combination of daily disturbances and insomnia severity. In fact, club athletes only differed from non-athletes on two non-sleep related variables: average weekly hours of exercise and reported weekly stress. Unsurprisingly, club athletes reported getting almost triple the weekly hours of exercise of non-athletes, and both the male athletes and male non-athletes reported getting more exercise than their female counterparts. Club athletes also reported feeling less stress over the previous week when compared to non-athletes.

For the combined samples overall, bivariate correlations revealed high concordance among the different sleep measures. Global sleep quality scores and the PSQI factor composites assessing sleep efficiency, perceived sleep quality, and sleep disturbances were each related to insomnia severity in the expected direction, and all except for sleep efficiency were similarly related to sleep hygiene. Greater weekly stress was also related to higher insomnia severity, worse sleep hygiene, and poorer global quality, and greater sleep disturbances. Sleep hygiene was the only sleep variable associated with hours of exercise, such that better sleep hygiene was associated with more weekly hours of exercise.

When considering additional functional implications of poor sleep, I hypothesized that poorer global sleep quality would be related to lower cumulative GPA for both club athletes and non-athletes, and that club athletes would have lower cumulative GPAs compared to college non-athletes. This hypothesis also produced null findings. Global sleep quality was unrelated to GPA and there was no difference in GPA between club athletes and non-athletes. Interestingly, however, the PSQI sleep efficiency factor composite was related to GPA, such that higher sleep efficiency scores were associated with higher GPAs overall. Taken together, these findings indicate that club athletes and non-athletes appear to have similar sleep profiles and that overall, better sleep is associated with less reported weekly stress, and higher sleep efficiency is related

to better academic performance. Conceptual implications of these findings will be discussed in the General Discussion.

General Discussion

This dissertation includes the first known study to examine sleep and its correlates in club athletes, and one of only a small number of studies that examines these relationships at any level of college athletics. In two separate studies, the aims of this dissertation were to report on the sleep patterns and quality of college club athletes using both objective and subjective measures (Study 1); examine the relationships among sleep, well-being, and performance in club athletes (Study 1); and compare subjective sleep variables and academic performance between college club athletes and non-athletes (Study 2). This dissertation provides the first known sleep profiles of college club athletes and demonstrates daily relationships between sleep and affect in this understudied population.

In Study 1, six nights of objective sleep data were collected from club athletes using wrist actigraphs, yielding both weekday and weekend measures of two common indicators of sleep quality (e.g., Ohayon et al., 2017), namely sleep efficiency and WASO, as well as a measure of sleep duration. In addition, self-reported sleep quality was assessed each night, and other sleep data (i.e., global sleep quality, sleep hygiene behaviors, and insomnia severity) were reported across a longer period of time. First, the sleep data collected from club athletes will be discussed within the context of sleep parameters reported in previous studies and the established guidelines for good sleep. Second, the associations among sleep and well-being variables in club athletes will be discussed, followed by findings on the relationships between sleep and next-day NA and PA. Third, I compare findings between club athletes and non-athletes on measures of subjective

sleep and academic performance. Limitations of the conducted research and study implications are also discussed.

Objective Sleep

As detailed below, the objective sleep duration data collected in this study are comparable to those obtained from other studies of collegiate athletes, but generally lower than those collected from elite athletes and general college samples, and are below the recommended range for healthy adults. Club athletes in this study slept 6.19 hours per night on average. Notably, the 6.19 hours of sleep measured in this study is below the recommended 7-9 hour healthy range for the club athletes' age group (Hirshkowitz et al., 2015). When compared to athletes, however, this average sleep duration is slightly less than the 6.68 hours of sleep reported in a study of NCAA-level college athletes using wrist actigraphy (Mah et al., 2011) but was similar to the average of 6.07 hours of sleep obtained in another study with male NCAA-level football players (Burke et al., 2020). However, several studies of college-aged elite athletes (e.g., those involved in Olympic and other high-level national competitions) reported greater actigraphy-measured average sleep durations, ranging from 6.92 to 7.37 hours (Ayar, Karacabey, Aksu, & Ayar, 2019; Leeder, Glaister, Pizzoferro, Dawson, & Pedlar, 2012; Robey et al., 2014). In comparison to club athletes in this study, general samples of college students also had longer sleep durations as assessed using actigraphy, with values ranging from 6.38 to 7.10 hours (Doane, Gress-Smith, & Breitenstein, 2014; Kahlhöfer, Karschin, Breusing, & Bosy-Westphal, 2016), except for a sample of working college students whose 5.5 average hours of sleep was notably lower (Teixeira et al., 2012).

When considering WASO, the objective records indicate that club athletes were awake during the night for approximately 1 hour on average. This value is well above the 20-minute

maximum suggested cut-off for good sleep quality (Ohayon et al., 2017), but is in the middle of the range that has been previously reported in the limited studies conducted with athletes. That is, the athletes in this study were awake during the night for less time than that reported for a sample of elite Olympic athletes (approximately 1.28 hours; Leeder et al., 2012) but more time than that reported for a very small sample of elite soccer players (approximately 15 minutes; Robey et al., 2014). Overall, the sleep efficiency scores recorded in this sample were similar to scores obtained from samples of NCAA college and elite athletes, as well as those from general college samples. The 84.34% sleep efficiency for club athletes in this study approximated the 85% suggested cut-off for good sleep quality in healthy adults (Ohayon et al., 2017). In comparison with other athletes, the sleep efficiency measurement for the club athletes tested in this study was lower than the 89.85% reported for NCAA-level college athletes (Burke et al., 2020) and was in the middle range of sleep efficiency scores reported in another actigraphy studies of elite athletes, which ranged from 80.6% to 89% (Ayar et al., 2019; Leeder et al., 2012; Robey et al., 2014). The sleep efficiency recorded for the club athletes in this study was similarly within range of scores from general college samples, which has ranged from 83.4% to 87% in previous research (Doane et al., 2014; Kahlhöfer et al., 2016; Teixeira et al., 2012).

Self-Reported Sleep

Overall, both the global sleep quality scores reported by club athletes in this study as well as the percentage of club athletes with categorically poor sleep scores, appear within range of the scores and percentages reported across studies of other college and elite-level athletes. Club athletes reported a PSQI global sleep quality score of 5.52, and 47% of athletes had categorically poor sleep quality (i.e., global sleep quality scores exceeding 5). These global sleep quality scores were comparable to the reported average from a large sample of NCAA college athletes,

which was recorded at 5.38 (Mah et al., 2018), but somewhat worse than average scores from studies of NCAA college soccer players (4.99; Benjamin et al., 2020) and NCAA college football players (4.48; Burke et al., 2020). The 47% of categorically poor sleepers in the present study was well within the range of categorically poor sleepers (26% to 54%) reported across the other three NCAA athlete studies. Similarly, a systematic review of elite athlete sleep studies showed that across college-aged samples, average PSQI global scores ranged from 5 to 6, with 38% to 50% of elite athletes reporting categorically poor sleep (Gupta, Morgan, & Gilchrist, 2017).

Interestingly, PSQI global scores across two large studies of general college students were markedly worse than those reported in this dissertation. In one study of over 7,000 students, the average PSQI global score was 6.87, with 61.9% of students reporting categorically poor sleep (Becker et al., 2018). In a second study of over 1,000 students, means were 6.7 and 7.2 (reported separately for males and females, respectively), with 65.9% categorized as poor sleepers (Lund et al., 2010). Although the global sleep quality scores of the club athletes in this study were comparable to the values obtained in other studies of NCAA-level college and elite athletes, club athletes had notably higher average global sleep quality than reported in large studies of general college students. Likewise, club athletes in this study had a similar percentage of categorically poor sleepers as reported in other studies of NCAA-level college and elite athletes, but a smaller percentage of categorically poor sleepers than reported in large studies of general college students.

The average insomnia severity scores reported by club athletes in this study were below the clinical range reported for this measure (Bastien et al., 2001) and were in-between the range reported in one study of NCAA-level athletes (Burke et al., 2020) and general college students

(Gellis, Stotsky, & Taylor, 2014; Kloss et al., 2016). Average insomnia severity scores for club athletes were reported at 7.03, somewhat higher than those of NCAA male football players (6.22) reported in previous work (Burke et al., 2020), but lower than those reported in studies of college students more generally, in which scores ranged from 8.6 to 9.23 (Gellis et al., 2014; Kloss et al., 2016) and were on average below the 8-14 range for sub-clinical insomnia (Bastien et al., 2001). Comparisons to insomnia severity scores in elite athletes were not possible, as relevant studies were not identified. Finally, club athletes in the present study reported average sleep hygiene scores of 19.99. These scores were very similar to those reported by general college students in another study (Seun-Fadipe, Aloba, Oginni, & Mosaku, 2018) but markedly lower than the average scores of 29.26 reported in a study of elite international athletes (Biggins et al., 2019). Comparisons of sleep hygiene scores across studies could only be done with a small subset of the available literature due to differences in measure scoring; several studies (including the present dissertation studies) scored items on the Sleep Hygiene Index (Mastin et al., 2006) using a scale of 0-4, whereas others utilized a scale of 1-5.

Relationships Among Sleep, Well-Being, and Performance

In addition to the sleep data discussed above, club athletes were also asked to report on both daily (i.e., PA and NA) and weekly (i.e., stress, athletic coping, self-rated athletic performance) indicators of well-being to examine relationships among these variables and their daily and global sleep scores. The average daily subjective sleep quality (i.e., Karolinska) and average monthly global sleep quality (i.e., PSQI) scores reported by club athletes had similar relationships with other sleep and well-being variables. That is, both measures of sleep quality were related to lower insomnia severity ratings, better sleep hygiene, and less weekly stress; subjective sleep quality was also related to higher GPA. The general similarities between the

correlates of both average daily and monthly global sleep quality ratings with the other measures of interest suggests that club athletes were consistent when evaluating their sleep both daily and globally over the past month.

However, it is unclear why only average daily sleep quality, and not global sleep quality, was associated with GPA. Considering that GPA was cumulative and thus assessed over a longer period (i.e., at least one academic quarter), a stronger association between GPA and a broader sleep quality measure (i.e., monthly) versus a shorter-term measure (e.g., average daily) might be expected, particularly if consistency was apparent in indices of global sleep quality over time. However, although stability in PSQI global sleep quality scores across a year has been demonstrated in middle-aged adults (Knutson, Rathouz, Yan, Liu, & Lauderdale, 2006), a study of college students demonstrated that PSQI global scores significantly improved as an academic semester progressed (Pilcher & Ott, 1998); repeated assessments over longer periods of time have not been identified in the literature. Therefore, it is possible that with college students, sleep quality during certain parts of academic terms may be differentially important for their overall academic success that term. For example, if some students generally get better sleep toward the end of the quarter, they may perform better on final assignments and exams than those who have the opposite sleep pattern, and therefore earn better grades overall. It is also possible that club athletes plan their academic course loads so that courses they consider to be easier are scheduled during their busier athletic seasons, and more difficult courses are scheduled during the offseason. Future studies should adjust for possible systematic fluctuations in sleep quality that may occur as the academic term progresses by evenly distributing testing periods throughout the term. Similarly, measures of GPA for the academic term in which the testing period takes place, in addition to overall GPAs, should be collected in future studies.

Sleep hygiene was significantly related to both daily and global subjective sleep quality as well as to insomnia severity. Poorer sleep hygiene was also related to higher NA, more stress, and poorer athletic coping. These findings suggest that club athletes with worse sleep hygiene behaviors also experience poor and disrupted sleep as well as poorer indicators of well-being. Although the correlational nature of this study precludes any causal inferences about the relationships of sleep hygiene with sleep quality and well-being in club athletes, previous research indicates that causal relationships exist. That is, some studies have demonstrated that interventions aimed at improving sleep hygiene awareness are effective in improving both subjective (Brown et al., 2002) and objective (O'Donnell & Driller, 2017) sleep in general college students (Brown et al., 2002) and in elite athletes (O'Donnell & Driller, 2017).

Interestingly, self-rated athletic performance was unrelated to any sleep variables. Overall, the findings in the limited literature on sleep and performance in athletes are mixed, with some studies demonstrating significant relationships (Fullagar et al., 2015; Mah et al., 2011), and others not (Blumert et al., 2007; Lastella, Lovell, & Sargent, 2014). This inconsistency in findings may be partially explained in that some mechanisms by which sleep can affect athletic performance (e.g., physiological, cognitive, emotional) may be more or less critical for different sports-related demands (Fullagar et al., 2015). Differences in findings may also be explained by variance in the timing and methodology of sleep and performance measurement in studies. For example, in one study of college basketball players, sleep duration was experimentally increased across multiple weeks, resulting in improvements in sprint time and shooting accuracy (Mah et al., 2011). In another study of athletes across multiple sports, only a minority of athletes believed that their poor sleep negatively impacted their performance even though the majority of participants reported getting poor sleep the night before a

competition (Erlacher, Ehrlenspiel, Adegbesan, & El-Din, 2011). These latter findings seem to parallel the findings of the present study more closely, in which poorer sleep was unrelated to the club athletes' subjective evaluations of their athletic performances. Future studies with club athletes should incorporate both subjective and objective measures of performance and should examine whether the sleep-performance relationship is different when performance is assessed during practice and active competition.

Overall, subjective sleep measures were mostly unrelated to objective sleep measures and subjective sleep had a greater number of significant associations with well-being than did objective sleep. These findings were unsurprising in that little concordance between subjective and objective sleep measures was found in previous studies (Aili et al., 2017; Girschik et al., 2012; Jackowska et al., 2016; Lauderdale, 2008; Matthews et al., 2018). In addition, none of the objective sleep measures, when averaged across the week, were related to measures of well-being (i.e., stress, affect, athletic coping), whereas several significant relationships were observed among subjective sleep measures and well-being as discussed above. Findings indicating that subjective sleep had a greater number of significant associations with well-being relative to measures of objective sleep may reflect a mood bias that is present when one is reflecting on their sleep. That is, when an individual retrospectively reports on their sleep quality, these reports may be partially influenced by the person's affective states at the moment, thus confounding their sleep ratings (Krystal & Edinger, 2008; Tworoger et al., 2005). The discrepancy between subjective and objective sleep measures and associations with well-being may also be a result of a measurement bias, such that subjective measures are more likely to correlate with other subjective measures than with objective ones (Goelema et al., 2017). Finally, because objective and subjective sleep measures are likely capturing different aspects of

sleep (Aili et al., 2017), future studies of sleep in club athletes should not only include both subjective and objective measures of sleep, but also include subjective and objective measures of well-being and performance (e.g., physiological stress measures such as cortisol and performance measures such as speed or reaction time).

Daily Sleep and Mood

The third aim of this study was to examine how daily PA and NA fluctuate based on objective and subjective sleep recorded the previous night. As hypothesized, club athletes reported higher PA following nights on which they also reported good quality sleep. These findings are consistent with past studies on sleep and next-day PA (e.g., Konjarski, Murray, Lee, & Jackson, 2018). However, significant relationships were not found between PA and sleep duration, sleep efficiency, or WASO recorded from the previous night. Findings were also mixed for NA; as predicted, participants reported less NA when they had higher than average sleep efficiency and higher self-reported sleep quality the previous night. These findings are in agreement with previous multi-day studies of sleep and affect (for review, see Konjarski, Murray, Lee, & Jackson, 2018). However, findings for sleep duration and WASO were also significant, but in the opposite direction. That is, longer nightly sleep duration was related to higher next-day NA whereas greater WASO was associated with lower next-day NA.

Konjarski and colleagues (2018) systematically reviewed multi-day studies of sleep and next-day affect using subjective and objective sleep measures, whose collective findings were somewhat consistent with those from the present study. The authors reported a handful of studies that found relationships between poor subjective sleep and next day NA, but none of five objectively measured sleep studies reported a significant relationship. However, one actigraphy study of sleep and next-day affect in college students indicated that greater sleep duration was

related to lower next-day PA (Takano, Sakamoto, & Tanno, 2014). The authors suggested that the unexpectedly reduced PA after longer sleep may be a result of oversleeping and subsequent feelings of daytime sleepiness, a common weekend occurrence for undergraduates (Takano et al., 2014). Similarly, college students are prone to experiencing high levels of depressive symptoms (Beiter et al., 2015) and oversleeping is commonly associated with mood disorders (Kaplan & Harvey, 2009). Further, both low PA and high NA are associated with greater depressive symptoms (Watson, Clark, & Carey, 1988). Therefore, similar to the aforementioned findings by Takano and colleagues (2014), it is possible that the association between longer sleep duration and higher next-day NA found in the present study can be accounted for by the affective consequences of oversleeping. Future studies should screen for depressive symptoms when examining relationships between sleep and affect to identify whether divergent relations are found for students who do and do not experience depressive symptoms.

Greater WASO was also surprisingly related to lower next day NA in the present study. It is possible that with the unique sleep environments of many college students, where late night in-person and digital interactions with peers are common, students with long periods of time awake during the night may have awoken to socialize, possibly buffering against negative moods the following morning. Future studies should ask students to report on their activities during night-time awakenings to better understand how activities completed during nighttime awakenings impact next day affect.

The findings indicating that sleep is associated with next day PA and NA in club athletes may have important implications not only for the athletes' daytime functioning but also for their athletic performance. Studies of both college and elite level athletes have demonstrated the relationship between poor sleep and negative mood including increased anxiety, depression,

tension, anger, fatigue, and confusion (Andrade et al., 2019; Beedie, Terry, & Lane, 2000; Benjamin et al., 2020). Furthermore, some studies have found significant relationships between pre-competition mood and subsequent performance, whereby better athletic performance was associated with lower pre-performance reports of tension, depression, and confusion, as well as with increased vigor (Andrade, Bevilacqua, Coimbra, Pereira, & Brandt, 2016; Beedie et al., 2000). Additionally, sleep deprivation may increase the risk of moodiness and irritability in athletes, and thus may adversely affect their interactions with other players and coaches (Bolin, 2019).

Comparisons of Subjective Sleep Between Athletes and Non-Athletes

Contrary to what I hypothesized for Study 2, there were no significant differences between club athletes and non-athletes on any subjective sleep variables assessed in this study (average subjective sleep quality, sleep hygiene, and insomnia). When this study was designed, I based this hypothesis on the limited existing literature on NCAA-level college athletes that suggests that these individuals often obtain poor and insufficient sleep (Mah et al., 2018; Penn Schoen Berland, 2015; Wilson & Pritchard, 2005) and that their sleep tends to be worse during the athletic season relative to the off-season (Sexton-Radek et al., 2013). Although poorer sleep quality is also quite common in college non-athletes (Buboltz et al., 2001; Gaultney, 2010; Lund et al., 2010; Orzech et al., 2011), I anticipated that the college club athletes would report poorer sleep because they manage the usual stressors of college life along with added pressures of balancing academics with training and competition schedules, maintaining peak physical health, and managing pain, fatigue, and injury associated with sports participation (Armstrong, Burcin, Bjerke, & Early, 2015; Cosh & Tully, 2015; Simons, Rheenen, & Covington, 1999). However, this expectation was not realized.

There are several possible explanations for the lack of significant differences across sleep parameters between club athletes and non-athletes in this study. First, it appears unlikely that club athletes, in general, experience the same extracurricular loads as do NCAA-level athletes. One large study of NCAA-level athletes found that during their active seasons, many athletes spend an average of 50 hours per week on athletics-related activities, 21 of which were directly spent on mandatory athletic activities and another 29 hours on related activities including voluntary workouts or training. In contrast, club athletes in this study reported spending approximately 15 total weekly hours on exercise, although the time spent on other athletic-related activities for club athletes was not assessed. Therefore, it may be the case that club athletes in this study spend a comparable amount of time on athletic-related activities to the time non-athletes spend on other extracurricular activities such as club participation, hobbies, or paid work. Future studies comparing club athletes and non-athletes should ask about time spent across all school and outside activities. Additionally, the high levels of stress previously reported by NCAA-level athletes (Surujlal et al., 2013) is another reason I hypothesized that club athletes in the present study would sleep poorly, as higher stress is generally associated with poorer sleep (e.g., Vandekerckhove & Cluydts, 2010). However, somewhat counterintuitively, club athletes in this study reported less weekly stress than did non-athletes. Although participating in club sports may possibly be related to increased stress from the additional time constraints and responsibilities, this stress may be buffered by the psychological benefits (e.g., social support) associated with participating in team sports (Kimball & Freysinger, 2003).

Relationships Between Sleep, GPA, and Athlete Status

In Study 2, I also examined GPA as a potential functional outcome of sleep quality, but results did not support the hypothesized relationship between better global sleep quality and

higher GPA, nor my expectation that club athletes would have lower GPAs than non-athletes. Global sleep quality was unrelated to GPA and no differences in GPA were found between athletes and non-athletes. The findings in the present study that club athletes and non-athletes did not differ in their GPAs was surprising. I expected club athletes to have poorer GPAs relative to non-athletes based on previous studies with NCAA-level athletes. The group differences reported in previous research may have been due to athletes' indications that their athletic activities conflicted with their academic obligations (Potuto & O'Hanlon, 2007), or because of the high levels of stress they reported due to the challenges of balancing sports and academics (Surujlal et al., 2013). However, other studies suggest that academics likely suffer most for athletes involved in higher-profile sports such as football and basketball, where pressure to succeed is the highest (Pascarella et al., 1999; Paule-Koba & Farr, 2013; Umbach, Palmer, Kuh, & Hannah, 2006). It is unlikely that the club athletes in the present study experience this level of pressure since they do not have athletic scholarships to defend and are not at risk of being cut from their teams due to poor athletic performance. However, future studies with club athletes should ask about the athletes' attitudes and motivations regarding their participation in club sports.

Interestingly, however, the PSQI sleep efficiency factor composite was related to GPA, such that higher sleep efficiency scores were associated with higher GPA overall. The fact that only a PSQI composite score but not the PSQI global score was related to GPA is unexpected, as past studies have demonstrated a positive relationship between global sleep quality and GPA in college students (e.g., Gilbert & Weaver, 2010). However, when examining club athletes in Study 1, global sleep quality was also unrelated to GPA. It is possible that the lack of relationships between global sleep quality and GPA in both studies is related to unique characteristics of this sample when compared to other studies. In the present study, club athletes

and non-athletes had similar PSQI global sleep quality scores, both of which were notably lower than those reported in two previous large studies of college students (Becker et al., 2018; Lund et al., 2010). Further, the two aforementioned large studies of college students included predominately Caucasian participants (over 80%), whereas participants in the present study are more ethnically diverse. Participants in the present study also had a variety of academic majors, whereas no information was provided on the distribution of majors across the other studies. Nevertheless, the results of Study 2 suggest that club athletes and non-athletes do not differ their self-reported sleep nor in their academic achievement.

Limitations and Future Directions

The present dissertation was the first to examine sleep and its correlates in a sample of club athletes, as well as to compare sleep and well-being between club athletes and college non-athletes. Given the novelty of the studies in this dissertation and the sparse literature on sleep in college athletes upon which the present studies were built, there are a number of future directions in which some limitations of the present studies should be addressed. First, although athletes were successfully recruited from each of the most competitive club sports on campus, the 70 club athletes recruited for this study are only a small percentage of the approximately 1,700 annual participants in club sports at UC Irvine. Future studies should attempt to recruit a greater number of club athletes to (a) provide a more representative sample of club athletes across campus and (b) allow for statistical comparisons between athletes from different sports. Furthermore, additional covariates that may influence the experiences of club athletes should be included in future studies such as the duration of the athletes' involvement in their sports and their reported levels of commitment to their sports. Although the present dissertation was unique in utilizing both subjective and objective sleep measures with club athletes, only subjective

measures of athletic performance were captured. Future studies should additionally include objective athletic performance measures (e.g., speed, accuracy, game performance) to examine whether they have different relationships with sleep and well-being than do the subjective measures. Similarly, significant relationships were found between sleep and next day affect for club athletes, but no objective indicators of well-being (e.g., stress hormones) were measured and should be included in future studies examining sleep and well-being in club athletes. Future studies should also assess the frequency and duration of daytime naps, as napping has been shown to be restorative after sleep loss (Milner & Cote, 2009) and should be accounted for when assessing sleep and its correlates.

With regards to comparisons between club athletes and non-athletes, the two groups were tested during different academic quarters, thus potentially obscuring possible differences in sleep that may surface when testing periods are aligned. However, considering that students in some majors may generally attain poorer sleep than students in other majors, testing club athletes before non-athletes allowed me to recruit non-athlete participants across similar majors to the club athletes. In future studies, recruiting a larger sample of club athletes should result in a broader distribution of majors within this group, thus increasing the chances that simultaneously testing non-athletes will naturally capture a similar major distribution to that of the athletes. In the present dissertation, I also did not inquire about the total time committed to any extracurricular activities (e.g., club sports, work, volunteering) for athletes and non-athletes, which in future studies would help contextualize the time burden of club sports participation relative to those activities completed by non-athletes. Finally, no study to my knowledge has included comparisons of NCAA-level athletes, club athletes, and non-athletes together, and future studies should recruit members of all three groups to examine potential differences in

sleep, well-being, and academic performance. Despite these limitations, the present dissertation studies fill a gap in the literature by reporting on the relationships among sleep and its correlates in college club athletes and non-athletes.

Conclusions and Implications

Although a handful of studies have examined sleep and well-being in NCAA-level college athletes, this is the first known study to describe the patterns and correlates of sleep in a sample of college club athletes, thus providing a benchmark for comparisons in future studies. Notably, this dissertation also reported on sleep in club athletes using both subjective and objective measures and, as such, adds to the small body of literature that includes objective measurements of sleep for any level of college athlete. Although club athletes and non-athletes did not differ in their sleep profiles or GPAs, important relationships between sleep and next-day affect were found for club athletes. Notably, athletes reported lower NA on days after which they had above average sleep efficiency and self-reported sleep quality the previous night, as well as higher PA after nights of better self-reported sleep. Additionally, for club athletes, better sleep hygiene was related to both higher daily and global subjective sleep quality and to lower reported insomnia severity. Taken together, it is possible that for club athletes, improvements in sleep hygiene may correspond with improvements in sleep quality and better next day affect. Considering approximately 1,700 students enrolled at UC Irvine identify as club athletes, these findings contribute to our understanding of sleep and well-being in this sizeable, yet understudied population.

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Appendix A

Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?

USUAL BED TIME

_____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES

_____

3. During the past month, when have you usually gotten up in the morning?

USUAL GETTING UP TIME

_____

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)

HOURS OF SLEEP PER NIGHT

_____

Instructions: For each of the remaining questions, circle the one best response. Please answer all questions.

0 = Not during the past month, 1 = Less than once a week, 2 = Once or twice a week, 3 = Three or more times a week

5. During the past month, how often have you had trouble sleeping because you…

(a) …cannot get to sleep within 30 minutes.

0 1 2 3

(b) …wake up in the middle of the night or early morning.

0 1 2 3

(c) …have to get up to use the bathroom.

0 1 2 3

(d) …cannot breathe comfortably.

0 1 2 3

(e) …cough or snore loudly.

0 1 2 3

(f) …feel too cold.

0 1 2 3

(g) …feel too hot.

0 1 2 3

(h) …have bad dreams.

0 1 2 3

(i) …have pain.

0 1 2 3

(j) Other reason(s), please describe.

_____

_____

How often during the past month have you had trouble sleeping because of this?

0 1 2 3

6. During the past month, how would you rate your sleep quality overall?

Very Good Fairly Good Fairly Bad Very Bad

7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?

0 1 2 3

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

0 1 2 3

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No Problem Very Slight Problem Somewhat Problem Very Big Problem

10. During the past month, what has been your sleeping arrangement?

No Bed Partner or Roommate Partner/Roommate in Other Room

Partner in Same Room, Different Bed Partner in Same Bed

→ If you have a roommate or bed partner, ask him/her how often in the past month you have had…

(a) …loud snoring.

0 1 2 3

(b) …long pauses between breaths while asleep.

0 1 2 3

(c) …legs twitching or jerking while you sleep.

0 1 2 3

(d) …episodes of disorientation or confusion during sleep.

0 1 2 3

Other restlessness while you sleep; please describe.

_____

_____

Appendix B

Insomnia Severity Index

For each question, please CIRCLE the number that best describes your answer.

Please rate the CURRENT (i.e. LAST 2 WEEKS) SEVERITY of your insomnia problem(s).

Insomnia Problem	**None**	**Mild**	**Moderate**	**Severe**	**Very Severe**
1. Difficulty falling asleep.	0	1	2	3	4
2. Difficulty staying asleep.	0	1	2	3	4
3. Problems waking up too early.	0	1	2	3	4

4. How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?

Very Satisfied	Satisfied	Moderately Satisifed	Dissatisfied	Very Dissatisfied
0	1	2	3	4

5. How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?

Not Noticeable	A Little	Somewhat	Much	Very Much Noticeable
0	1	2	3	4

6. How WORRIED/DISTRESSED are you about your current sleep problem?

Not Worried	A Little	Somewhat	Much	Very Much Worried
0	1	2	3	4

7. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) CURRENTLY?

Not Interfering	A Little	Somewhat	Much	Very Much Interfering
0	1	2	3	4

Appendix C

Sleep Hygiene Index (SHI)

Below you will find a list of statements. Please rate how true each statement is for you by circling a number below it. Use the scale to make your choice.

0 = Never 1 = Rarely 2 = Sometimes 3 = Frequent 4 = Always

1. I take daytime naps lasting two or more hours.

0 1 2 3 4

2. I go to bed at different times from day to day.

0 1 2 3 4

3. I get out of bed at different times from day to day.

0 1 2 3 4

4. I exercise to the point of sweating within 1 hour of going to bed.

0 1 2 3 4

5. I stay in bed longer than I should two or three times a week.

0 1 2 3 4

6. I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed.

0 1 2 3 4

7. I do something that may wake me up before bedtime (e.g., play video games, use the internet, or clean).

0 1 2 3 4

8. I go to bed feeling stressed, angry, upset, or nervous.

0 1 2 3 4

9. I used my bed for things other than sleeping or sex (e.g., watch television, read, eat, or study).

0 1 2 3 4

10. I sleep on an uncomfortable bed (e.g., poor mattress or pillow, too much or not enough blankets).

0 1 2 3 4

11. I sleep in an uncomfortable bedroom (e.g., too bright, too stuffy, too hot, too cold, or too noisy).

0 1 2 3 4

12. I do important work before bedtime (e.g., pay bills, schedule, or study).

0 1 2 3 4

13. I think, plan, or worry when I am in bed.

0 1 2 3 4

Appendix D

Athletic Coping Skills Inventory-28

Instructions: The following are statements that athletes have used to describe their experiences. Please read each statement carefully, and then recall as accurately as possible how often you experience the same thing. There are no right or wrong answers. Do not spend too much time on any one statement.

Please circle how often you have experiences when playing sports.

[0 = Almost Never, 1 = Sometimes, 2 = Often, 3 = Almost Always]

1. On a daily or weekly basis, I set very specific goals for myself that guide what I do.

0 1 2 3

2. I get the most out of my talent and skill.

0 1 2 3

3. When a coach or manager tells me how to correct a mistake I've made, I tend to take it personally and feel upset.

0 1 2 3

4. When I'm playing sports, I can focus my attention and block out distractions.

0 1 2 3

5. I remain positive and enthusiastic during competition, no matter how badly things are going.

0 1 2 3

6. I tend to play better under pressure because I think more clearly.

0 1 2 3

7. I worry quite a bit about what others think of my performance.

0 1 2 3

8. I tend to do lots of planning about how to reach my goals.

0 1 2 3

9. I feel confident that I will play well.

0 1 2 3

10. When a coach or manager criticizes me, I become upset rather than feel helped.

0 1 2 3

11. It is easy for me to keep distracting thoughts from interfering with something I am watching or listening to.

0 1 2 3

12. I put a lot of pressure on myself by worrying about how I will perform.

0 1 2 3

13. I set my own performance goals for each practice.

0 1 2 3

14. I don't have to be pushed to practice or play hard; I give 100%.

0 1 2 3

15. If a coach criticizes or yells at me, I correct the mistake without getting upset about it.

0 1 2 3

16. I handle unexpected situations in my sport very well.

0 1 2 3

17. When things are going badly, I tell myself to keep calm, and this works for me.

0 1 2 3

18. The more pressure there is during a game, the more I enjoy it.

0 1 2 3

19. While competing, I worry about making mistakes or failing to come through.

0 1 2 3

20. I have my own game plan worked out in my head long before the game begins.

0 1 2 3

21. When I feel myself getting too tense, I can quickly relax my body and calm myself.

0 1 2 3

22. To me, pressure situations are challenges that I welcome.

0 1 2 3

23. I think about and imagine what will happen if I fail or screw up.

0 1 2 3

24. I maintain emotional control regardless of how things are going for me.

0 1 2 3

25. It is easy for me to direct my attention and focus on a single object or person.

0 1 2 3

26. When I fail to reach my goals, it makes me try even harder.

0 1 2 3

27. I improve my skills by listening carefully to advice and instruction from coaches and managers.

0 1 2 3

28. I make fewer mistakes when the pressure is on because I concentrate better.

0 1 2 3

Appendix E

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

In the last week, how often have you been upset because of something that happened unexpectedly?

0 1 2 3 4

In the last week, how often have you felt that you were unable to control the important things in your life?

0 1 2 3 4

In the last week, how often have you felt nervous and "stressed"?

0 1 2 3 4

In the last week, how often have you felt confident about your ability to handle your personal problems?

0 1 2 3 4

In the last week, how often have you felt that things were going your way?

0 1 2 3 4

In the last week, how often have you found that you could not cope with all the things that you had to do?

0 1 2 3 4

In the last week, how often have you been able to control irritations in your life?

0 1 2 3 4

In the last week, how often have you felt that you were on top of things?

0 1 2 3 4

In the last week, how often have you been angered because of things that were outside of your control?

0 1 2 3 4

In the last week, how often have you felt difficulties were piling up so high that you could not overcome them?

0 1 2 3 4

Appendix F

Karolinska Sleep Diary

1. At what time did you go to bed and turn the light off last night? _____PM or AM

2. At what time did you arise this morning? _____PM or AM

3. How long did you sleep? _____hours and _____minutes

4. How long did it take you to fall asleep? _____hours and _____minutes

5. How many awakenings did you have last night? _____

6. How many total minutes were you awake after falling asleep last night? _____minutes
(Don't include time in bed before falling asleep?)

Circle one per question only:

7. How did you sleep?

1	2	3	4	5
Very Poorly				Very Well

8. Did you feel refreshed after you arose this morning?

1	2	3	4	5
Not at all				Completely

9. Did you sleep soundly?

1	2	3	4	5
Very Restless				Very Soundly

10. Did you sleep throughout the time allotted for sleep?

1	2	3	4	5
Woke up much too early				Slept through the night

11. How easy was it for you to wake up?

1	2	3	4	5
Very Easy				Very Difficult

12. How easy was it for you to fall asleep?

1	2	3	4	5
Very Easy				Very Difficult

13. How much did you dream last night?

1	2	3	4	5
None				Much

Appendix G

Positive and Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. Indicate to what extent you feel this way right now, that is, at the present moment OR indicate the extent you have felt this way over the past week (circle the instructions you followed when taking this measure).

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

_____ 1. Interested

_____ 2. Distressed

_____ 3. Excited

_____ 4. Upset

_____ 5. Strong

_____ 6. Guilty

_____ 7. Scared

_____ 8. Hostile

_____ 9. Enthusiastic

_____ 10. Proud

_____ 11. Irritable

_____ 12. Alert

_____ 13. Ashamed

_____ 14. Inspired

_____ 15. Nervous

_____ 16. Determined

_____ 17. Attentive

_____ 18. Jittery

_____ 19. Active

_____ 20. Afraid