

Sleep Patterns of Young Men and Women Enrolled at the United States Military Academy: Results from Year 1 of a 4-Year Longitudinal Study

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Study Objectives: Sleep patterns of young adults are different from those of other age groups. This study examined sleep patterns of cadets during their first year at the United States Military Academy.

Design: This paper presents initial results of a 4-year longitudinal investigation into sleep patterns of college-age men and women.

Setting: Data were collected at the United States Military Academy, a 4-year undergraduate institution that develops men and women in 4 areas: intellectual, physical, military, and moral-ethical.

Participants: Survey data were obtained from all members of the Class of 2007 (N=1300), who ranged in age from 17 to 22 years. A stratified sample (n = 80) was selected to wear wrist-activity monitors. An additional 40 members of the junior and senior classes participated in the summer portion of the study.

Measurements and Results: Sleep patterns prior to entering the United States Military Academy were compared with patterns during cadet basic

training and fall and spring semesters. Actigraphy data were recorded on a sample of the class (n = 80) for 50 days during cadet basic training and 30 days during fall and spring semesters. During cadet basic training, incoming cadets received 5 hours 40 minutes of sleep per night. During fall 2003 semester, these same cadets received 4 hours 50 minutes of sleep on school nights and 6 hours 32 minutes on weekends. Sleep received during spring 2004 semester was similar, with 5 hours 06 minutes on school nights and 6 hours 29 minutes on weekends.

Conclusions: This first year of baseline data collection describes cadet sleep patterns and sets the stage to assess the effectiveness of follow-on interventions.

Keywords: Sleep deprivation, actigraphy, adolescent sleep patterns

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INTRODUCTION

RESEARCH HAS SHOWN THAT THE SLEEP PATTERNS AND SLEEP REQUIREMENTS OF ADOLESCENTS AND YOUNG ADULTS ARE DISTINCTLY DIFFERENT FROM THOSE of other age groups.¹⁻⁵ When compared to adults, the circadian fluctuation of the naturally occurring hormone melatonin differs in adolescents and is thought to reflect the underlying processes that control sleep patterns.⁶ In this population, melatonin is released later, peaking and dropping off later. Consequently, this population tends to go to bed later but is less able to wake up early in the morning. Adolescents have extremely variable sleep patterns, tending to sleep less on week nights compared with weekends, when sleep is reportedly more satisfactory.⁷

The present study is part of a longitudinal research effort that will investigate sleep patterns of cadets at the United States Military Academy (USMA) at West Point, NY, over a 4-year period. The study provides an opportunity to observe sleep in a college-age population. Additionally, the study serves as a test bed for examining sleep and performance in the Future Force/Future Soldier. These 2 groups, the USMA cadets and the Future Force/Future Soldiers, share many similarities: they are approximately the same age, they both work in an environment with a high cognitive demand, and both groups are self-selected to serve in the mili-

tary.

Cadets at USMA have limited opportunities for sleep. Unlike other college populations, they are required to awaken early, with their first formation at 6:45 AM. However, many cadets are awake long before that hour to participate in athletic activities. In addition, they are required to attend all academic classes and meals, leaving few chances for naps and catch-up sleep. These cadets almost certainly get less sleep than their peers at nonmilitary institutions. Under these conditions, many types of performance are likely to be degraded, including performance in academic, athletic, and military domains. However, the prevailing culture within the United States military tends to be one in which depriving oneself of sleep is a means of demonstrating commitment to the mission and the organization, as well as mental and physical toughness.⁸ In a recent interview, a high-ranking US Army officer was asked how much sleep he thought leaders needed each day during sustained operations in order to be effective. He responded by saying that about 3.5 hours of sleep every 24 hours would be enough to sustain a leader indefinitely. Empirical findings do not support this response.

A preponderance of scientific evidence shows that human perception, cognition, and decision making suffer when people are sleep deprived.^{9,10} Belenky et al⁹ conducted a study in which 66 participants (ranging in age from 24 to 62 years) were randomly divided into 4 groups. After 3 days of baseline testing on a psychomotor vigilance task, the groups received either 3, 5, 7, or 9 hours of sleep for 7 days. At the end of the 7 days, the groups were permitted to sleep 8 hours per night during the recovery phase of the study. Participants were administered the psychomotor vigilance task throughout the 7 days of sleep restriction and 3 days of recovery sleep. By the seventh day of the sleep-restricted period, the performance of the 3-hour group was only 50% of baseline performance. Even after 3 days of recovery sleep, the 3- and 5-hour groups were unable to achieve performance levels

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This was not an industry supported study. Drs. Shattuck and Miller have indicated no financial conflicts of interest.

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commensurate with baseline levels.

A related study by Van Dongen et al¹⁰ examined performance from individuals assigned to 3 different levels of sleep deprivation: 4, 6, and 8 hours per night. Performance was tracked over 14 days of sleep restriction. In this same study, a separate group was totally sleep deprived for 3 days, and their performance was also recorded. After 2 weeks of sleep restriction, performance in the 4- and 6-hour groups was equivalent to that of individuals who had been totally sleep deprived for 2 or 3 nights of sleep. Another important finding from this study was that, although cognitive performance was degraded in all sleep conditions, high ratings of subjective sleepiness were reported only in the group with the most severe sleep restriction.

Findings from these studies demonstrate the profound effect of both acute and chronic sleep loss on cognitive performance. Recovery from severe sleep loss will not occur overnight or even after 3 nights of normal sleep. The studies allude to the insidious nature of chronic sleep deprivation: although performance is severely degraded, only those in the most severely restricted group report being sleepy.

The relationship between memory and sleep is especially important when studying this population. USMA cadets are constantly being exposed to new information and expected to retain and build on this information. Debate persists regarding the relative importance of various sleep stages but increasing evidence supports the idea that adequate sleep is a requirement for effective learning and memory.¹¹⁻¹⁶

Sleep has been studied extensively using actigraphic recordings and sleep logs in selected populations, eg, infants and children and various adult and clinical populations. However, it is only recently that sleep of college-age populations has received much attention with universities such as Duke changing policy to delay class start times from 8:00 AM to 8:30 AM.¹⁷ While there are scientific abstracts detailing efforts to assess sleep patterns in college-age students, this area has not received sustained attention from the sleep research community.¹⁸⁻²⁰ The current research effort is an attempt to remedy this gap.

METHOD

Participants

In the present study, survey data were obtained from all members of the USMA Class of 2007 ($N \sim 1300$). A stratified sample of the class was selected to wear wrist activity monitors (WAM). This sample consisted of 80 cadets, selected on the basis of sex, unit (company to which the cadet was assigned), and athletic status (participation on either an intramural or an intercollegiate athletic team). The Corps of Cadets is comprised of approximately 85% men and 15% women. In order to have sufficient number of women in the study for statistical purposes, women were over sampled. Therefore, the 80 cadets in the sample included 56 men (70%) and 24 women (30%). Half of the cadets in the sample were intercollegiate athletes and half were intramural athletes. Ten cadets from each of the 8 companies were included in the sample. At the beginning of the study, all members of the Class of 2007 ranged in age from 17 to 22 years. An additional 40 members of 2 upper classes participated in the summer portion of the study. These members of the Classes of 2004 and 2005 served as cadre who supervised the instruction and training of the Class of 2007 during their initial summer training. The upper-class

cadets ranged in age from 19 to 25 years. Cadre members only participated in half of the 6-week cadet basic training. Of the 40 cadre members, 20 participated in the first half (first detail) of the training and 20 participated in the second half (second detail) of the training. Cadre members were selected to participate based on both sex and the leadership echelon to which they were assigned (squad, platoon, company, or regiment). The sample for each detail consisted of 14 men (70%) and 6 women (30%). The composition by echelon reflected the demographics of the cadre population: 8 squad level (40%), 4 platoon level (20%), 4 company level, (20%) and 4 regiment level (20%). Participants were treated in accordance with ethical standards established by the American Psychological Association. The research methods used in this study were approved by the USMA Human Subjects Use Committee. All participants completed an informed consent form prior to participating in the study.

Equipment

WAM developed by the MiniMitter Company (Bend, Ore.) were used to collect sleep data from the cadets. Data from the WAM were analyzed using MiniMitter's Actiware software program. The software facilitated the calculation of sleep duration, sleep efficiency, and sleep latency. Actigraphy data from selected cadets were entered into the Fatigue Avoidance Scheduling Tool package. The Fatigue Avoidance Scheduling Tool is based on the human fatigue model selected by the Department of Defense, called the Sleep and Fatigue Task Effectiveness model. The Sleep and Fatigue Task Effectiveness model is patented by Hursh and his colleagues and is used to predict cognitive effectiveness from a given individual's actigraphy.²¹ The paper-and-pencil activity log filled out by the cadets to indicate their activities throughout the day and night was developed by the authors and tailored to the environment at the Academy.

Procedures

Young men and women enter USMA during the summer and participate in 6 weeks of cadet basic training. Members of the Class of 2007 reported for duty on June 30, 2003. All members of the Class were surveyed within 72 hours upon entering the Academy. The survey was developed by the researchers and was based on the Pittsburgh Sleep Quality Index.²² Cadets were asked for demographic data and information about their sleep patterns during the month prior to arriving at the Academy. They were also asked to provide information about their use of tobacco products, their intake of caffeine, and any over-the-counter or prescribed medications they had taken recently. The 40 cadre members from the Classes of 2004 and 2005 also completed a demographic survey at the beginning of cadet basic training. Another survey was administered to all members of the Class of 2007 and the 40 cadre members from the Classes of 2004 and 2005 at the end of cadet basic training.

Eighty members of the Class of 2007 wore WAM throughout cadet basic training. Twenty cadre members wore WAM during the first detail of cadet basic training and another 20 cadre members wore WAM during second detail of cadet basic training. The same 80 members of the Class of 2007 also wore WAM for approximately 30 days during the fall 2003 academic semester and again for approximately 30 days during the spring 2004 academic semester. While wearing the WAM during the fall 2003 semester,

the cadets were also asked to fill out an activity log. The log divided each day into 15-minute segments. Cadets entered single-letter codes to indicate the type of activity in which they were engaged for each 15-minute segment. While wearing the WAM during the spring 2004 semester, the cadets were asked to record their activity on personal digital assistants. These same 80 members of the Class of 2007 will continue to wear the WAM for a 30-day period during each semester through spring 2007. This paper focuses on results from cadet basic training (summer 2003) as well as the fall 2003 and spring 2004 semesters.

RESULTS

Data From Summer 2003

Initial demographic surveys were completed by 1290 members of the Class of 2007 (> 98% compliance) and by 40 cadre members from the Classes of 2004 and 2005 (100% compliance). Surveys administered at the conclusion of cadet basic training were filled out online. As a result, compliance rates for new cadets and cadre were much lower (72% and 59%, respectively). Survey data indicate that most members of the Class of 2007 reported bedtimes of between 11:00 PM and 1:00 AM during the 30 days prior to their entry to the Academy. Most of those surveyed reported wake times between 8:00 AM and 10:00 AM. The average amount of sleep reported was 8 hours 23 minutes (SD = 1.62 hours).

During cadet basic training, activities of the members of the Class of 2007 were mandated by a daily training schedule. This schedule indicated that these cadets were to be in bed from 10:00 PM until 5:00 AM, affording them not more than 7 hours of sleep per night. The training schedule indicated that cadre members were to be in bed from 11:00 PM until 5:00 AM, affording them not more than 6 hours of sleep per night. However, nearly all cadets received less than the maximum amount of possible sleep because of the demands placed on them by the rigors of cadet basic training. The amount of sleep received by cadre ranged from an average of 4 hours per night to 6 hours 30 minutes per night (mean = 5 hours). Cadre at the company echelon received the least amount of sleep (mean = 4 hours 36 minutes), whereas cadre at the platoon level received the greatest amount of sleep (mean = 5 hours 24 minutes), though the difference between these 2 groups was not statistically significant. Analysis revealed that cadets in the Class of 2007 who were wearing WAM received an average of 5 hours 40 minutes of sleep per night. A question on the survey conducted after cadet basic training asked all cadets to indicate the amount of sleep they thought they received during cadet basic training. The subjective responses of the 80 cadets wearing WAM indicated they believed they were sleeping for approximately 5 hours 50 minutes per night. Based on data from the WAM, this estimate is within 10 minutes of the amount of sleep they actually received.

Data From Fall Semester 2003

Eighty members of the Class of 2007 wore WAM from mid-November 2003 through mid-December 2003. These were the same 80 cadets who wore WAM during cadet basic training, with the exception of 7 cadets (8.75%) who either resigned from the Academy or chose to drop out of the study. Those 7 cadets were replaced by other cadets who matched them demographically. They also maintained activity logs on paper. This period

included 2 weeks of normal academic activities, Thanksgiving holiday week (a week in which cadets have 2.5 days of classes and 4.5 days of vacation), and a week of final examinations. Data on bedtime, wake time, and actual sleep, as determined by actigraphy, are shown in Table 1. School nights were defined as those that were followed by days with classes (normally Sunday through Thursday). Nonschool nights were those that preceded weekends (Friday and Saturday) and holidays. The weekday academic schedule begins with a breakfast formation at 6:45 AM, but there is no mandatory bedtime.

Not unexpectedly, cadets went to bed later and slept in on weekends as compared with school nights. On average, cadets received only 4 hours 50 minutes of sleep on school nights, considerably less than the 8.5 to 9.25 hours recommended by sleep experts.¹

Data From Spring Semester 2004

Eighty members of the Class of 2007 wore WAM from early-April 2004 through early-May 2004. These were the same 80 cadets who wore WAM during fall 2003 academic semester, with the exception of 2 cadets (2.5%). One cadet was separated from the Academy for academic reasons and the other chose to drop out of the study. These cadets were replaced by other cadets who matched them demographically. All participants maintained activity logs on personal digital assistants. This data-collection period consisted of approximately 4 weeks of normal academic activities with no holiday or examination periods. Data on bedtime, wake time, and actual sleep, as determined by actigraphy, are shown in Table 2.

Fall 2003 and spring 2004 actual sleep, bedtime, and wake times were consistent. Figure 1 demonstrates this consistency across academic semesters. The higher standard deviations in the fall are due to the shift in sleep patterns that occurred during both Thanksgiving weekend and the week of final examinations.

DISCUSSION

Survey data from cadet basic training indicate that the members of the Class of 2007 are fairly typical for their age group with respect to the amount of sleep they receive. According to Carskadon, adolescents require 8.5 to 9.25 hours of sleep per night.¹ As stated above, prior to arriving at USMA, members of the Class of 2007 self-reported that they received, on average, 8.39 hours of sleep per night. The bedtimes and wake times they reported prior to arriving at the Academy were consistent with the circadian pattern of melatonin in adolescents.¹⁸

Upon arrival at cadet basic training, however, their average sleep dropped to 5.67 hours per night, a 34% reduction. Although melatonin levels of the cadets were not measured, the researchers

Table 1—Average Actual Sleep, Bedtime, and Wake Time by School Night Condition (Fall 2003).

	School Night	Nonschool Night	Combined
Actual Sleep	4 h 50 min SD = 1 h 15 min	6 h 32 min SD = 2 h 18 min	5 h 20 min SD = 1 h 48 min
Bedtime	12:31 AM SD = 1 h 18 min	1:40 AM SD = 2 h 03 min	12:51 AM SD = 1 h 39 min
Wake Time	5:56 AM SD = 45 min	9:08 AM SD = 2 h 28 min	6:53 AM SD = 2 h 05 min

Table 2—Average Actual Sleep, Bedtime, and Wake Time by School-Night Condition (Spring 2004)

	School Night	Nonschool Night	Combined
Actual Sleep	5:06 AM	6:29 AM	5:27 AM
	SD = 55 min	SD = 1 h 36 min	SD = 1 h 20 min
Bedtime	12:31 AM	12:58 AM	12:38 AM
	SD = 1 h 02 min	SD = 1 h 19 min	SD = 1 h 10 min
Wake Time	6:11 AM	8:16 AM	6:44 AM
	SD = 36 min	SD = 2 h 02 min	SD = 1 h 35 min

compared actual sleep and wake times of the cadets to the natural rise and fall of adolescent melatonin levels reported in previous research.²³ The cadet basic training schedule required them to go to bed prior to their natural elevation of melatonin and wake up prior to its decline. This transition in sleep patterns from high school to cadet basic training is severe, especially compared with the transition experienced by their peers at nonmilitary institutions. Carskadon and Davis surveyed incoming Brown University students during the spring semester of their senior year in high school and again during the fall semester of their freshman year at Brown.¹⁸ During spring of the senior year in high school, the students reported receiving an average of 6.98 hours of sleep on weeknights and 8.75 hours of sleep on weekends. As freshmen at Brown University, they reported receiving an average of 6.67 hours of sleep on weeknights and 8.15 hours of sleep on weekends. These data indicate the transition from high school to college resulted in just a 4% reduction in weeknight sleep and a 7% reduction in weekend sleep.

The USMA Class of 2007 actigraphy data from the fall 2003 and spring 2004 semesters are remarkably consistent. Cadets received only about 5 hours of contiguous sleep on school nights and about 6.5 hours on the weekend. Cadets had a mean bedtime of 12:31 AM and a mean wake time of 6:11 AM on school nights. The study by Carskadon and Davis found that students at Brown University reported a median weeknight bedtime of 1:00 AM to 1:59 AM and a median rise time of 8:00 AM to 8:59 AM.¹⁸ These times are generally consistent with the rise and decline of adolescent melatonin levels.²³ The earlier wake time of cadets is due primarily to their early-morning athletic activities as well as a mandatory breakfast formation and is a major reason why cadets received less sleep on school nights than students at Brown University. It should be noted that during the 2003 to 2004 academic year, although cadets had a mandatory formation at 6:45 AM, they did not have a mandatory bedtime.

A dramatic reduction in sleep, coupled with a shift in bedtimes and wake times is likely to have an impact on performance. Comments by senior members of the USMA faculty after the fall 2003 semester suggest that sleep deprivation may indeed have had an effect on academic performance. When discussing cadets who had performed poorly, faculty members made reference to cadets who regularly fell asleep in class or who seemed to understand material when they attended additional instruction sessions but who did not seem to remember anything the next day. Although beyond the scope of this present article, as part of the longitudinal study, the researchers are also compiling attrition data, as well as academic, physical, and military performance data. These data will be analyzed and reported in subsequent articles.

When individuals are deprived of adequate sleep on weeknights, it is important for them to diminish their accrued sleep

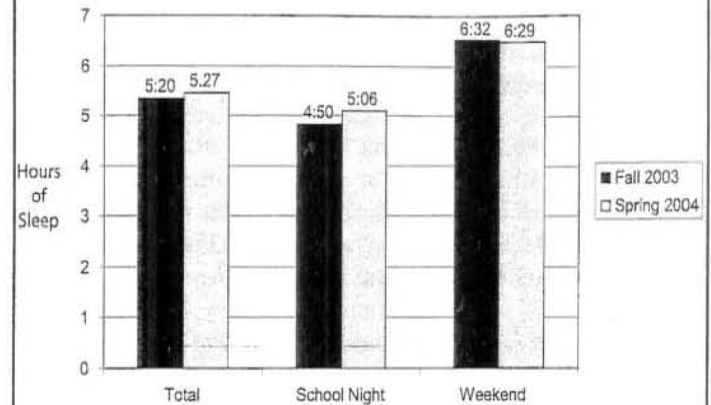


Figure 1—Comparison of actual sleep received by participants during fall 2003 and spring 2004 academic semesters.

debt on the weekend. Students in the Brown University study apparently were able to get 'catch-up' sleep. Those surveyed by Carskadon and Davis reported sleeping approximately 8.15 hours on the weekend.¹⁸ Cadets at USMA received an average of approximately 6.5 hours of sleep on the weekend, 20% less than their peers in the Brown University study. It follows that the USMA cadets were less likely to diminish their accrued sleep debt than the students in the Brown University study and that the cadets were more likely to experience the effects of chronic sleep loss.^{9,10}

Conducting a longitudinal study in any natural laboratory is risky business because researchers often have little control. Such has been the case in this longitudinal study. To their credit, when the researchers informed the Academy leadership team of their findings from the first year of the study, the leadership team formulated and implemented policies that they hoped would increase the amount of sleep cadets received on both weeknights and weekends. The impact of these interventions will be analyzed by researchers in subsequent years of the longitudinal study. The interventions include the following.

Lights-Out Policy

Beginning in the fall 2004 semester, cadets were required to turn out their lights no later than midnight on weeknights. Cadet and officer chains of command were charged with enforcing the policy. Prior to that semester, cadets could stay up as late as they desired; however, they still had to be present at the 6:45 AM breakfast formation.

Napping

Prior to the fall 2003 semester, cadets were restricted from taking naps before noon. Beginning in the fall 2004 semester, cadets were permitted to take naps after 9:30 AM. Nap analysis is being conducted on both the fall 2003 and fall 2004 data and will be reported in subsequent articles.

Education

Modifications were made to the curriculum of selected courses at the Academy. For example, the General Psychology course, taken by all freshmen cadets now includes findings from the first year of the longitudinal study and the implications of both acute and chronic sleep loss. In addition many academic departments

have undertaken initiatives to educate their faculty concerning the sleep study and the implications of sleep deprivation with respect to learning.

Screening

Selected organizations that are intended to provide assistance to cadets have begun to include sleep-hygiene issues as part of their screening process. For example, counselors at the Center for Enhanced Performance and the Center for Professional Development now routinely ask cadets about their sleep habits and explain the link between proper sleep hygiene and performance.

The findings of the initial portions of this longitudinal study are important because they provide baseline data for this group of young men and women and they served as an impetus for the Academy's leadership team to make decisions which the researchers hope will lead to better sleep hygiene among cadets. The importance of instilling good sleep habits in cadets at USMA and providing them with an appropriate knowledge of the effects of chronic and acute sleep deprivation cannot be overstated. As previously mentioned, the prevailing culture within the military tends to be one in which depriving oneself of sleep is a means of demonstrating mental and physical toughness. The young men and women who graduate from USMA are commissioned as second lieutenants in the United States Army and are charged with the leadership of soldiers in both war and peace. Leaders who understand the importance of sleep and its impact on performance will ensure that both they and their soldiers receive adequate rest. Such proper sleep hygiene could very well lead to better decisions and greater success on the battlefield.

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