

ADOLESCENT SLEEP: PATTERNS, PERCEPTIONS AND COPING BEHAVIORS

by

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A Dissertation Submitted to the Faculty of the

SCHOOL OF ANTHROPOLOGY

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College of

THE UNIVERSITY OF ARIZONA

2010

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

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entitled Adolescent Sleep: Patterns, Perceptions and Coping Behaviors (formerly "Miss, we're dying of sleepiness": Examining sleep in the social worlds of adolescents in the Southwest)

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ACKNOWLEDGEMENTS

With an undertaking as great as a dissertation that stretches over years, there are an innumerable number of people to thank, because without them, it would not have happened. They include:

My committee, Rhonda Gillett-Netting, Mark Nichter, Ivy Pike and especially Mimi Nichter, who leaped willingly into the breach to become my chair at the last minute and guide me through the final steps to the PhD.

My high school research participants and the administrators (including those in the district research office and the school), teachers and security personnel who helped me gain access to, and feel comfortable in, high school again.

My colleagues in the Anthropology department especially Jessica Piekelek, Anton Daughters, Laura Eichelberger, Christina Leza, Eric Pavri, Karin Friederic, Jenn Thompson and Julie Armin, and my best friend Margaret Walsh Rudmann, who all kept me sane and focused on the PhD goal, even when it seemed impossible.

My parents, JC and Mary McElveen, and my in-laws Pat and Phil Orzech, for endless support of many varieties, and also babysitting. My other babysitters, including Pete and Jen Orzech, Sharon Gaddis, and of course Janine Taranto, "Audrey's Janine".

And most of all, my husband Paul and my daughter Audrey, to whom this work is dedicated, for everything.

DEDICATION

To Paul Alexander Orzech and Audrey Marie Orzech.

After all of this, they deserve doctorates too!

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ABSTRACT

Sleep matters for adolescents. It matters for physical and mental health, for success in the classroom and in extracurricular activities, for safety while driving and for protection against potential future psychological problems and substance abuse. Although the recommended nightly amount of sleep for adolescents is over nine hours, many factors interact to preclude teens from getting the sleep they need. This study uses a biocultural, multi-method approach to examine how biological, cultural, and environmental factors interact to affect adolescent sleep behavior in a cohort of 50 high school freshmen in the United States. High school is a place where adolescents learn social and academic skills that will carry them into adult life, but it also provides a space where they are socialized into “how to sleep.” By exploring sleep and related behaviors, including ways to cope with inadequate sleep, in a group of teens who were 14 or 15 years old and evenly divided between White and Hispanic and male and female participants, this research explores how sleep is embedded within webs of individual, household-level, school-specific and societal factors. Beyond examining how advice about sleep and teens’ experience of sleep behavior is internalized and embodied by adolescents, special attention is paid to the relationships between personal technology use and sleep, and also to the relationships among sleep and food and caffeine intake.

CHAPTER 1: INTRODUCTION

Sleep is a paradoxical element of health. Typically, there is no immutable advice on how to sleep “better.” On the rare occasion when doctors address sleep they, might offer, “Get the sleep you need.” But how much does an “average adult” need? Six hours? Seven? Ten? Among teenagers, this becomes even more ambiguous. Lay ideas about sleep requirements abound and often conflict with researchers’ findings that teens should be sleeping more than 9 hours per night (Carskadon, 1999). “Be able to wake without an alarm in the morning” is good advice for getting adequate sleep, but this is likely to require going to bed at a time when many other things are happening, including engaging in activities outside the home like sports or other recreation, completing schoolwork, eating dinner, watching TV, communicating with friends or simply talking with your family. In order to investigate this paradox of how sleep fits – or does not fit – into the lives of everyday Americans, and how people think about it, I sought out perhaps the most sleep-deprived group in the United States for further study: high school students.

Inadequate sleep has serious, if not always well-publicized, short and long-term consequences for everyone who sleeps too little. Adolescents, who are still actively developing in physical, mental and emotional realms, however, are at increased risk for poor sleep and its associated consequences. The adolescent life stage balances puberty and mental and emotional growth, which are facilitated by sleep, with a strong desire to capitalize on new activities and social relationships, which often preclude sleep. With the

recent rapid rise of portable, on-demand communication and entertainment technology, teens have multiple ways beyond the phone to communicate with friends, and they can interact (for example, playing a video game together) even if they are in separate physical locations. The proliferation of cell phones also means that adolescents may communicate with friends in their rooms rather than using a house phone that may be more easily monitored by parents. All of these technological developments have a potentially negative impact on sleep time and sleep quality among teens, at a time when they need more sleep due to the maturational changes affecting their bodies and brains. **Table 1**, below, presents some of the major consequences of inadequate sleep for adolescents. These consequences will be discussed in further detail in Chapter 2 and in the Conclusion. They are introduced here to indicate that current sleep literature recognizes a variety of negative outcomes associated with inadequate sleep ranging from poorer memory for new information to potential death if inattention or sleep occurs at the wrong moment, such as when driving.

Table 1: Short and long term consequences of inadequate sleep

Short-term consequences	Long-term consequences
Higher depression, anxiety, lower self-esteem	Psychological problems, especially more anxiety, depression
Links to substance abuse	Links to substance abuse
Poorer self-regulation and impulse control	Potential for increased BMI
Poorer memory for new tasks or information, poorer performance on tasks, poorer grades	Potential for re-wired brains/prefrontal cortex effects
Trouble concentrating/paying attention	Setting up poor sleep patterns for the future
Increased chance of getting sick	
Injury or death from drowsy driving/falling asleep at the wheel	

To date, few anthropological studies have focused on sleep behavior in general, and none have focused on sleep behavior in adolescents. In order to investigate how adolescents balance their need for sleep with their desire to participate in social and other activities, I conducted a study from a biocultural perspective. A central element of biocultural anthropology thinking is the interrelationships among biological, cultural and environmental factors in human lives. Although there are earlier expressions of this biocultural paradigm, notably work by Wiley (1992) and McElroy (1990), a particularly comprehensive explanation of how anthropologists may conduct a biocultural study comes from Thomas' (1998) introductory chapter in the book *Building a New Biocultural Synthesis*. In this work, he suggests that in order to understand local social relations and their impact on health, it is important to investigate both the historical and political-economic context of a research site. Beyond this purview, researchers must also be attuned to local environmental conditions that promote or constrain actions (and

subsequently, health) among individuals. Finally, overlaying history, political economy and the local environment, the researcher should investigate the kinds of biological and cultural adjustments individuals are making to local conditions, including an examination of the effectiveness of these adjustments, their short and long-term consequences, and their potential position in a feedback loop, affecting the local biology, culture and environment.

Biocultural Model

Drawing on Thomas' description of biocultural studies, and the specific biocultural models put forth by McElroy (1990) and Gillett-Netting (n.d.), who privilege the overlap of biological, cultural and environmental variables, I constructed a biocultural model to graphically explain the interrelationships among biology, culture, environment, sleep behavior and coping behaviors that I will explore as part of my comprehensive study of adolescent sleep. This model, presented as **Figure 1** below, guides me both in the development of my major research questions, which will follow the model in this text, and also in the interpretation of my research findings in chapters 4 through 7.

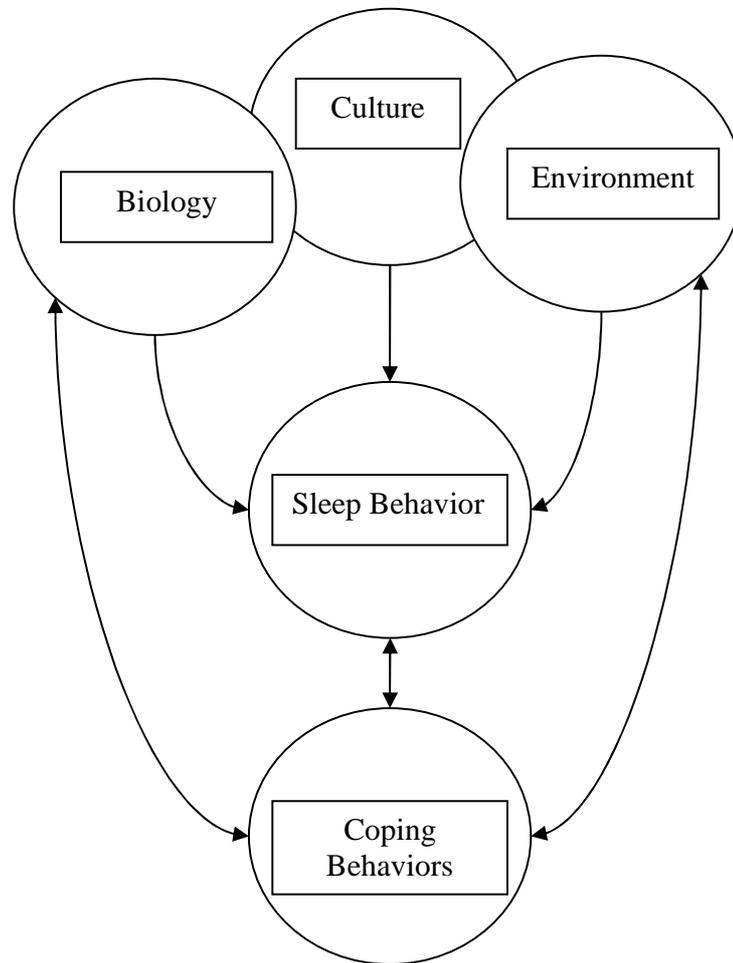


Figure 1: Biocultural model for sleep behavior

This model expresses a number of interactions, including the reality that biological, cultural and environmental elements all affect sleep behaviors, and that inadequate sleep leads to coping behaviors, which hopefully lead to changes that feed back into sleep behaviors, improving sleep. However, coping behaviors, like sleep behaviors, are affected by biological, cultural and environmental factors, and in order to impact sleep behaviors, coping behaviors must change some element of biology, culture or the

environment. This might be a short-term change, such as working over the course of several weeks to alter the body's biological expectation of sleep timing by going to bed the same early hour each night, or incorporating a regular nap into one's sleep schedule. Or it might be a long-term change, like lobbying the local school board to consider altering school start times for high school. This type of change could remove both an environmental constraint, having to rise at a particular time for school, and also a cultural one, the perception that first thing in the morning is the best time for everyone to perform at their peak (although this is frequently true for older adults (Vince, 2006)).

Research Questions

In order to explore the links implied by the biocultural model above, I recruited 51 high school freshmen to take part in a multi-method study that investigated their perceptions of their own sleep, their sleep patterns, relationships between their sleep and food intake, links between their sleep and technology use, and coping strategies used by these teens in the face of inadequate sleep. My five specific research questions to address these areas are:

- ❖ **How do adolescents in this population perceive their own sleep?** This includes an examination of factors that they think affect their sleep, their perceptions of sleep need and ideas about sleeping too much and too little, and their sources of information about sleep.
- ❖ **What constitutes "normal sleep" in this population of adolescents?**
- ❖ **What are specific ways in which adolescents cope with inadequate sleep? Do strategies vary with regard to household composition, gender, or ethnicity?**
- ❖ **What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?**
- ❖ **How does late-evening technology use interact with teen sleep in this population of adolescents?**

These questions are rooted in biocultural theory, and each contributes to a better understanding of adolescent sleep and its consequences. Thomas' (1998) focus on exploring the physical and social environment leads to my questions on *teen perceptions of sleep* as well as *what constitutes normal adolescent sleep* in this population. Both of these questions explore how cultural ideals of sleep, (shaped by the social environment), and demands placed on teens (by both the physical and social environment), interact with adolescent biology to produce both the teen sleep we see, and teens' perceptions of that sleep. The question of adolescent perceptions of their own sleep is of primary importance because teen perceptions are directly related to their normative sleep behavior. A focus on normal, everyday behavior, and a privileging of individual voices sets anthropology apart from other disciplines that study sleep, most notably psychology.

Embodied sleep

In addition, a primary focus on perceptions of sleep and actual sleep allows me to examine multiple levels of British sociologist Robert Meadows' (2005) typology of embodied sleep. Before explaining this typology, the terms "embodiment" and "culture" both require further explanation. Nancy Krieger explains that embodiment recognizes that "we, as humans, are simultaneously social beings and biological organisms" (Krieger, 2005 p. 350), and that clues to changing population patterns of health (in this case, sleep patterns) are likely to be found "in the dynamic social, material and ecological contexts into which we are born, develop, interact, and endeavour to live meaningful lives" (ibid.). Biocultural anthropologist William Dressler situates embodiment as a central concept in biocultural anthropology by asking how researchers make an "explicit effort to link collective meaning to individual behavior." He continues, "A biocultural perspective demands this, because a biocultural perspective is a study of embodiment in a very specific sense. It is the study of how experience gets written on the body in terms of measurable physiological, psychological and even morphological outcomes...and to do so it must trace culture to the individual" (Dressler, 2005 p. 24). Dressler's definition of "culture" is a very cognitive one, focusing on shared perception – essentially, what is in any individual's head in a given culture is a mix of a personal model of how their society works, and "cultural" or shared (consensus) model of the same. As I explore embodied sleep in my adolescent population, I will examine how sleep obtained by these teens reflects their experience of the intersection of their biology, cultural ideals transmitted to them about sleep, and powerful influences from both their social and physical

environments. To explore the abovementioned “cultural ideals” I use a definition of culture that includes both internal and external elements, following Kelso (2001). Internal elements include things like ideas, values, expectations and beliefs, while external elements include, for example, objects, institutions and behavior. As culture is experienced both cognitively (as suggested by Dressler) and behaviorally, accessing “cultural ideals” about sleep requires both interviews and participant observation.

Returning to Meadows’ (2005) typology of embodied sleep, I investigate how teens embody normative and pragmatic sleep by 1) asking adolescents what affects their sleep 2) asking them what advice they get from multiple sources on *how to sleep* and 3) conducting participant observation to see how teen perceptions match up with behavior. *Normative embodiment* includes opinions and perceptions of how to “sleep in a healthy way,” while *pragmatic embodiment* expresses an idea of what is “normal” for sleep in relation to one’s social role. Asking teens about their physical, mental and emotional experiences of sleeping too much and too little also enables examination of the *experiential embodiment* of sleep in this population, which Meadows defines as encompassing feelings related to sleep. Exploring what constitutes normal sleep in this population illuminates the intersection of *visceral embodiment*, which is the biological body’s contribution to sleep, as well as *pragmatic embodiment*, where teens seek to “sleep like a teenager.”

Coping with inadequate sleep

Turning once more to Thomas (1998), his emphasis on biological and cultural adjustments also leads to my questions about *coping behaviors that teens engage in when they judge their sleep to be inadequate* and also a specific potential coping behavior suggested in the recent literature – *consuming additional food or beverages, or altering physical activity in order to compensate for inadequate sleep the night before* (Gupta et al., 2002; Landolt et al., 2004; McLellan et al., 2005; Van Cauter and Knutson, 2008). In addition to being directly driven by biocultural theory, the question of coping behaviors is also important to begin to document how teen choices may have long-term effects on the biological, cultural and environmental variables that shape their sleep, as seen in the model above. Examining coping behaviors, specifically how adolescents determine if their sleep is inadequate enough to require behavioral change, also emphasizes the *negotiated* nature of sleep in adolescents. When to sleep, and how much to sleep are often negotiated within the self, based on physical tiredness, the availability of engaging activities, and environmental cues such as darkness. Relationships also influence sleep – and in the case of teenagers still living at home, it is clear that parents and adolescents participate in a process of negotiating teen sleep. Finally, investigating the specific coping behavior of increasing food intake provides both a point of comparison between this study and other studies concerned with effects of sleep on body mass index (BMI) (Knutson and Lauderdale, 2007; Taheri et al., 2004), and also allows me to utilize my human biology training to investigate the range of adolescent biological experience with regard to food intake and sleep, and explore how these elements link to the local context.

This focus on the range of adolescent experience clarifies why I chose to sample on ethnicity. In the local context, ethnicity is a potential source of population variation in both sleep and food intake.

Institutional impacts

Kelso (2001), laying down the main characteristics of biocultural anthropology in a web essay, echoes Thomas' contention that elements of culture affect biology, but also introduces a new element – tension between technological change and established institutions. He asserts that in our current era of rapid technological change, culture may not only assist humans in adapting to changing environmental conditions, but also hinder us as well. Kelso explains “Whereas technological innovation is the ultimate source of cultural novelty and as such often the source of disruption, social institutions and ideologies serve to integrate and to maintain or restore stability within cultural systems.”(Kelso, 2001, Section 5, Paragraph 6) While stability may be beneficial, conflict arises when social institutions and ideologies get too far out of touch with current realities. This is exactly what has happened with sleep timing in the United States. Recommendations for everyone to get a solid eight hours of sleep per night, with children generally advised to get more, are tied to a Fordist, 40-hour work-week paradigm that presumes a 9 to 5 job for a husband whose income is sufficient to support an entire family. While this reality may have been prevalent in the early to mid-twentieth century, today's post-Fordist era, as described by Harvey (1989) includes flexible, decentralized labor. This leads to an increase in part-time work and work by contractors, and also

encourages more employment of women in these roles. Even since Harvey's description of flexible accumulation in the late 1980's, American work schedules have become even more disassociated from a "typical" 9 to 5, 40-hour workweek, thanks to technological advances that make constant connection with the workplace possible. With these new flexible and "always-on" work arrangements, realities of time use do not match well with the Fordist-inspired sleep schedule of the previous era. Instead, flexible work and 24-hour leisure timing demand a more flexible sleep schedule, but especially for teens, school schedules and ideas of "ideal sleep" influenced by the past make "flexible sleep" an unrealizable goal. As Kelso concludes, "Beliefs created long ago become the criteria we use to make everyday decisions in the present" (Kelso, 2001, Section 5, Paragraph 7). Kelso's examination of the tension between the novelty of technological change and the stability of social institutions leads to my final research question about the *relationship between late-evening teen technology use and sleep*, which examines how the 24/7 availability of communication and entertainment (the "technology environment") may conflict with an established school schedule set up under a different social-economic system than the current one.

Sleep is a paradoxical health behavior because putting into action advice on "sleeping better" ideally requires changing the individual's current sleep behaviors. Sleep behaviors, however, are shaped not only by individual choice, but also by institutions that may not reflect present-day realities of economic systems, by social interactions, and by communication and entertainment technologies. Although this sense of the dual

“individual influence” and “cultural influence” is present in sleepers of all ages, it may be magnified in adolescents because of their specific biological differences with regard to sleep, as well as their legal requirement to be enrolled in high school, an institution where scheduling has definitely diverged from current knowledge about the best schedules to encourage adolescent alertness and learning (Hansen et al., 2005; Wolfson et al., 2007). This dissertation, by exploring teen perceptions of sleep, actual sleep behaviors, teen technology use, and ways of coping with inadequate sleep in a sample of 51 adolescents seeks to describe how biological, cultural and environmental realities intersect to produce the sleep we see in teenagers today.

Outline of the Dissertation

Following this introduction to my biocultural model and research questions, **Chapter Two** reviews the relevant literature that contextualizes this study, beginning with an examination of the biological and social consequences of inadequate sleep that may especially affect adolescents.

Conducting a study that captured data on sleep patterns, sleep perceptions, food intake and activity for at least 40 (the initial recruitment goal) 9th-grade adolescents over the course of more than one year, from October 2006 to November 2007, required a comprehensive multi-method research design, detailed in **Chapter Three**. Main methods included interviews, participant observation, short-term sleep diaries completed upon awakening, and prospective food, activity and technology diaries kept concurrently with

the sleep diaries for short (3-day) periods at up to three time points across the school year. Teens also completed several brief questionnaires on topics such as sleep behaviors and perceptions, and technology use.

Chapter Four begins by describing a typical day at the high school, which was my primary site for contact with my teen participants. This chapter addresses the question, **“How do adolescents in this population perceive their own sleep?”** This includes an examination of factors that they think affect their sleep, as well as their perceptions of how much sleep they need. In addition, I explore teens’ ideas about sleeping too much and too little, and their sources of information about sleep, both who (or what) the sources are, and the kind of information they provide to teens. I examine how adolescent sleep relates to the emerging “sleep industrial complex,” going beyond the experience of any individual teen to address the commodification of sleep in society at large, and then conclude with teen perception of sleep need and the possibility of sleeping “too much.”

Chapter Five asks **“How does late-evening technology use affect teen sleep in this population of adolescents?”** This question addresses the technology use that saturates the free time of many teens, and its effects on sleep. This examination of technology relates to an exploration by my participants of whether girls obtain less sleep than boys, because many teens in this sample think that girls get less sleep partially because they stay up later on their cell phones.

As mentioned above, the academic home of sleep studies is typically a department of psychology, psychiatry or medicine, and these disciplines often focus on sleep disorders in preference to characterizing “normal” sleep. From an anthropological perspective, however, what is normative in a population or a culture is often the most interesting.

Chapter Six presents data on total sleep time (the length of time from reported lights out to reported last awakening) and other sleep variables to answer, “**What constitutes "normal sleep" in this population of adolescents?**” I present mean sleep values for adolescents in this population for weeknights, weekend nights and summer nights. To contextualize this sleep data, I explore how adolescents conceptualize the effects of “too little sleep” on their physiology, mental abilities, and emotional lives. After discussing teen perceptions of what it is like to sleep “too little” and how it affects them, I return to the sleep diary data to examine two possible ways teens may change their behavior to cope with too little sleep – namely, napping and changing their sleep timing (altering bedtimes or wake times). This analysis begins to answer the questions, “**What are specific ways in which adolescents cope with inadequate sleep? And do strategies vary with regard to household composition, gender, or ethnicity?**”

Following this exploration of teen coping, I continue my examination of sleep diaries to elucidate any differences in sleep that may be related to ethnicity, gender or activity level in this population. Although some investigators have asked how sleep may differ by gender (Vallido et al., 2009), few have addressed ethnic differences (especially between White and Hispanic individuals, although see a series of articles by Roberts and

colleagues (2004; 2006; 2000) for some work in this area) and also differences in activity level (Brand et al., 2010) as factors that may interact with sleep.

Chapter Seven examines **coping with sleep loss** by altering food consumption (including fat consumption, used here as a proxy for “junk food” consumption, and caffeine consumption) or activity levels. Prior to investigating the sleep-food and sleep-activity relationships, Chapter Seven presents food intake and activity parameters for the entire sample, and then takes an in-depth look at sources of caffeine among the top 10 and bottom 10 caffeine consumers in the sample. Following this, the overall food and activity data are divided by ethnicity, gender, and activity level to see how food intake varies across these groups. I then use a standard-deviation approach to explore the food intake and activity patterns of teens who have slept one standard deviation longer than normal (comparing to the mean sleep time for a weeknight or weekend night) or who have slept one standard deviation less than normal. These data answer the question, **“What effect does longer or shorter sleep (as compared to a teen’s average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?”**

The **Conclusion** returns to themes introduced in the Introduction and Chapter Two, especially focusing on the short and long term consequences of inadequate sleep for adolescent health and development.

Appendix A provides a table of all methods used in this research, with appropriate descriptions and citations. **Appendix B** illustrates relationships between body mass index (BMI) and total sleep time in my sample to provide a point of comparison with recent research literature that often does not measure actual food intake, but instead uses a proxy of body mass index (BMI) to compare to sleep durations.

CHAPTER 2: THEORY AND BACKGROUND

To organize and present the literature that serves as the basis for this research, I return to the biocultural model depicted in **Figure 1**. This model posits connections and interplay among biological, cultural and environmental factors that directly affect adolescent sleep behavior. Adolescent sleep behavior, if it results in inadequate sleep, then leads to coping behaviors related to sleep. These coping behaviors are also affected by biological, cultural and environmental influences, and coping behaviors utilized by adolescents feed back into teen sleep behavior. The aim of this dissertation is to integrate biology, culture and environmental influences on sleep behavior into a single, multi-faceted picture of adolescent sleep behavior and coping behavior related to sleep, but the existing literature most often presents only a small part of this picture. In the pages that follow, I will briefly explore what is known about:

1) The biology of sleep behavior, specifically:

- The biology of adolescent sleep, situated within a larger literature of adolescent physical and mental development.
- The negative consequences (biological, psychological and other), both short and long-term, for adolescents who obtain inadequate sleep.
- Short term coping behaviors to address inadequate sleep, and how these are situated in a biological, cultural and environmental context in the United States (U.S.)

- The impact of short sleep on food intake, caffeine intake, and physical activity levels

2) Relationships between culture and sleep behavior, specifically:

- Theories advanced by anthropologists and sociologists about sleep in Western society
- Theories of time famine and the economic and social reality of flexible accumulation that directly affect sleep
- What is known about “the culture of adolescent sleep” in the U.S.

3) Environmental influences on sleep behavior, specifically:

- Sleep constraints imposed by high school
- The omnipresent technology environment and its effect on sleep

History of sleep studies

Recorded theories about why humans sleep may be traced back to the Greeks. In the 5th century B.C, Alcmaeon believed that sleep occurred when blood filled the brain vessels, with individuals waking up when the blood drained back out. Plato (427 – 347 B.C.) and Aristotle (384 - 322 B.C.) posited that “vapors from food decomposing in the stomach rose to the brain to cause sleep” (Dement and Vaughan, 1999 p. 29). Although likely based on sound observations (the tendency of individuals to fall asleep after a large meal) this theory was ultimately proven anatomically impossible. Though it is certain that

people speculated about sleep and its functions between the third century B.C. and the Renaissance¹, the next advancement noted by historians of sleep science occurred in 1729, when the French astronomer De Marian observed that the leaves of his mimosa plant followed a light/dark cycle, folding up when it became dark and opening when the sun rose. He confirmed that even when the mimosa was placed in a darkened cupboard, it still followed this cycle (Klein, 2007). This discovery began the science of chronobiology and paved the way for discoveries about the cyclical nature of sleep and other biological processes.

Jumping ahead to the early 1950's, scientists, their curiosity piqued by evidence of recordable electrical activity in the brain, became interested in exploring brain activity during sleep (For example, see Aserinsky and Kleitman, 1953). The ability to record the sleeping brain's activity enabled them to make inferences about the existence of different stages of sleep that humans and many other animals passed through during the night (Kleitman, 1960), from very light sleep to rapid-eye-movement (REM) sleep, to deeper, more restorative stage 3 and 4 sleep (Dement and Vaughan, 1999). As sleep science progressed from the early recording of the electrical activity of the brain during sleep, questions about sleep physiology became more specialized, although even into the early

¹ And in fact, historian A. Roger Ekirch has written a fascinating book entitled "At Day's Close: Night in Times Past" that discusses attitudes about night and behaviors at night from Roman times all the way through approximately 1900, with a focus on the "early modern" era between 1600 and 1800. Though sleep does play a part in his discussion, it is mainly tangential to his exposition of night, with the exception of the reality of segmented sleep, which will be discussed below in the section "evolutionary underpinnings."

1980's pioneers of sleep research were still publishing information on the basic rest-activity cycle (Kleitman, 1982).

Evolutionary underpinnings

Some of the main questions still explored by sleep researchers today are evolutionary ones, including “Why do we sleep?” and “What is the ancestral pattern for human sleep?” Examination of these questions reflects an abiding interest in human behavior and what shapes it, including evolution. Darwin’s theory of descent with modification, through the action of natural selection and other evolutionary forces (Darwin, 1958 [1859]; Mayr, 2001) applies as well to sleep as it does to other constellations of behavior that shape what it is to be human. Two theories of why humans (and other animals) sleep are presented below, followed by evidence for the ancestral pattern of human sleep. Two additional theories of the function of human sleep that articulate with adolescent development will be presented later in this chapter.

The main functional answer to “why do we sleep” discovered thus far seems to be a connection between sleep and learning, specifically memory consolidation (Curcio et al., 2006; Gais et al., 2002; Mednick et al., 2003; Wagner et al., 2001), where subjects (adults and adolescents) who slept after learning facts or tasks performed more accurately in experiments that asked them to recall those facts or perform those tasks again. Contrary to this focus on sleep for learning and memory consolidation, however, Siegel (2009), based on analysis of data on sleep across species in mammals, proposed that sleep is best

seen as a state of “adaptive inactivity,” a variant of dormant states found throughout the plant and animal kingdoms. This hypothesis and the learning/memory hypothesis described above are not necessarily mutually exclusive. In fact, though Siegel’s idea of sleep as a state of adaptive inactivity is a minority view among sleep researchers, he focuses on the fact that mammals sleep for very disparate amounts of time, and the length of their sleep does not seem related to body mass, except weakly among herbivores (Siegel, 2009) or basal metabolic rate. Therefore, a parsimonious explanation for sleep’s function may be that it began as adaptive inactivity, sleeping when it was not ecologically beneficial to forage, mate, or engage in other activities. After a sleep pattern was established, it then took on additional functions (Gould and Lewontin, 1979), such as memory consolidation. The main drawback to this sort of unified theory, however, is that of perhaps 4,000 mammalian species, only 60 to 70 have had their sleep tested in any way (Siegel, 2009), leaving much unknown about sleep in the animal kingdom and across broader phylogenetic divisions.

As for the ancestral pattern of sleep, based on both historical documents from the early modern period in Europe and America (1600-1800) (Ekirch, 2005) and late twentieth-century lab research (Wehr, 1992), it seems that this sleep pattern may be biphasic. This means that prior to widespread artificial lighting, and in modern times when artificial light is removed experimentally, humans sleep for three to five hours, wake for one to three hours, and then sleep again until dawn. This pattern is far removed from what we see in the West today, where sleep is typically consolidated into one uninterrupted block.

If individuals deviate from that pattern, their sleep is deemed “disordered.” I speak only to Western patterns here, because there is a dearth of published literature documenting sleep patterns and timing across much of the non-Western world. Anecdotal evidence suggests, however, that modern sleep patterns vary according to environmental and social variables, with some populations sleeping in a biphasic manner while others sleep in a more consolidated way, often shifting sleep timing to match natural light cycles. This type of biphasic sleep pattern documented by Ekirch and Wehr would have held evolutionary advantages, however, as not everyone would wake in the night at the same time. While there might have been times when multiple individuals were awake and even active, such a sleep pattern allows for watchfulness throughout the night without specifically designating a sentry.

The biology of adolescent sleep behavior

Adolescent sleep biology in the context of adolescent development

Although sleep science began in earnest in the 1950’s, in the mid-1970’s researchers began to study adolescent sleep, primarily focusing on how adolescent biology differed from that of adults, and how this affected their sleep (Carskadon et al., 1980). By the 1990’s, adolescent sleep attracted even more attention as scientists began to discover that the adolescent brain was still developing, and that sleep interacted with this maturation process (Dahl and Lewin, 2002).

Adolescents' biological uniqueness with regard to sleep and arousal is still an area of active investigation. Researchers have defined three biological elements that directly affect sleep: circadian rhythms, homeostatic sleep drive, and autonomic nervous system balance (Hirshkowitz, 2004). Biologically, adolescents demonstrate different circadian rhythms than adults, with circadian clocks that favor phase-delay. That is, they want to stay up later and get up later (Dahl and Lewin, 2002). Although adolescent sleep has not been studied in all parts of the world, study results from the United States, Western Europe, and parts of Asia (specifically Japan, Korea, Taiwan and Hong Kong) support this adolescent sleep pattern as predominant at least in Westernized nations (Carskadon et al., 1993; Multiple Authors, 2007; Park et al., 2002; Tynjala et al., 1993; Yang et al., 2005). Adolescents also have an altered homeostatic sleep drive (Jenni et al., 2005). Despite physical fatigue, adolescent brains may not communicate a demand for sleep. Hirshkowitz' third element, autonomic nervous system balance, is also problematic in teens, because behaviors such as anxious worrying and/or caffeine consumption near bedtime can keep adolescents awake.

Across adolescence, young people undergo many developmental changes, and it is now known that sleep plays an integral part in this process. Recent research has found that brain development continues during puberty and beyond (Nelson, 2004). Specifically, adolescents are still experiencing the development and refinement of brain functions associated with impulse control, sensation seeking and affective control (Dahl, 2004). Although the exact functions of sleep in this process are still unknown, sleep appears to

be particularly important during periods of brain maturation. Across species, maturing individuals require more sleep than fully mature ones (Dahl, 1999). A review by Dang-Vu and colleagues (2006) summarizes the major long-term effects of sleep on brain development demonstrated in rats and cats. Several studies support the finding that rats chemically deprived of REM sleep show depression as adults. The cerebral cortex and brainstem were also smaller in these sleep-deprived rats. In studies of young cats involving REM-sleep deprivation's effect on the developing visual system, researchers found that sleep-deprived cats had smaller cells associated with their visual systems, and much slower responses to visual stimuli. Finally, in a study where researchers either allowed cats to sleep or kept them awake during critical periods following modifications to their visual systems (including covering one eye for extended periods), researchers found that the cats who obtained additional non-REM sleep showed improved cortical remodeling in response to the visual system modifications.

Another hypothesis of why we sleep includes a "neuronal pruning" hypothesis, suggested by Crick and Mitchison (1983) as a function of REM sleep, and later refined by Tononi and Cirelli (2006), given improved knowledge of sleep architecture, to occur during slow-wave sleep. The thesis of both papers is that sleep removes unnecessary connections from the brain in order to make room for additional information. Though technology is not yet advanced enough to monitor such change at the neuronal level, the later paper provides specific details about how and when such pruning might take place, encouraging the formal testing of this hypothesis. This hypothesis may be particularly

critical in adolescent development, as recent research shows that growth in the prefrontal cortex, peaking just before puberty and followed by a period of neuronal pruning during adolescence, is a key mechanism of adolescent brain development (Giedd et al., 2009)

This pruning and myelination (the wrapping of white matter around neuronal connections to strengthen them) occurs to a large degree in the prefrontal cortex, which controls the majority of executive functioning, including control of attention, arousal and goal-directed behaviors (Dahl, 1996). In imaging studies, adolescents seem to engage fewer prefrontal regulatory processes than adults when making decisions, leaving them more prone to risk taking in some situations (Dahl, 2008). A separate line of research has shown that “the sleep pattern associated with adolescence – that is, lower quantity and quality of sleep – is associated with less reactivity of reward-related brain systems” (Holm et al., 2009 p. 330). The data collected by these authors is consistent with pubertal adolescents requiring more “exciting” rewards to match the neuronal activation they would experience with a less exciting reward before puberty, and lack of sleep exacerbates this relationship. Therefore, the biological and developmental changes associated with puberty and adolescence tend to require more sleep, but the social characteristics of adolescence (more time spent in social pursuits) tend to restrict sleep, with potentially negative consequences for teen risk-taking.

Short and long-term consequences of inadequate sleep in adolescents

Given that adolescence is still a time of active brain development, what might be the consequences associated with inadequate sleep during this life stage? Longitudinal studies are rare, but a few described below provide insight on the potential future negative consequences of adolescent sleep deprivation. Better known are the short-term consequences of inadequate sleep that plague adolescents and adults alike. Among the most common findings are relationships between inadequate sleep and higher depression and anxiety, and lower self-esteem. Fredriksen and colleagues (2004) tracked relationships among sleep patterns, depressive symptoms, self-esteem and academic performance across middle school (6th – 8th grades) in a cohort of 2000+ students in Chicago. They found that sleep declined across grades, with a steeper decline for girls (who started out sleeping slightly more) than boys. Students who reported less sleep in the 6th grade showed lower initial self-esteem and academic performance, and higher levels of depressive symptoms. As they followed these young teens across middle school, researchers documented that as sleep time declined for individual teens, so did self-esteem measures, while the sleepier teens' depression measures rose. According to Roberts and colleagues find that across multiple studies, “adolescents with disturbed sleep report more depression, anxiety, irritability, fearfulness, anger, tenseness, emotional instability, inattention and conduct problems” (Roberts et al., 2002 p. 562). Of course, research has also clearly expressed that poor sleep may also be a symptom of or exacerbating factor for disorders such as depression and anxiety, and not necessarily a

cause of them; all of the psychiatric issues mentioned above are complex and require careful analysis to tease apart how various factors influence one another.

In addition to these psychological problems, chronic inadequate sleep has also been linked with substance abuse. Roane and Taylor (2008), performed cross-sectional analysis on archival data from the National Longitudinal Study of Adolescent Health (Add Health), examining variables related to sleep, psychological problems and substance abuse. They found that their insomnia sufferers, who indicated they had trouble falling asleep or staying asleep every day or almost every day over the past 12 months, were more likely than non-insomniacs to report alcohol use, marijuana use and the use of drugs other than marijuana as well as more depressive symptoms, thoughts of suicide, and suicide attempts. Mednick and colleagues (2010), also initially analyzing Add Health data and then following up with a subset of students, use social network analysis to trace the spread of both poor sleep (sleeping ≤ 7 hours per night) and marijuana use (using at least once per month). They found that if a friend slept ≤ 7 hours, it increased the likelihood that the person being studied (ego) slept ≤ 7 hours by 11%. If a friend used marijuana, it increased ego's likelihood of marijuana use by 110%. Finally, the likelihood that ego used drugs increased by 19% when a friend slept ≤ 7 hours. These authors' mediation analysis showed that 20% of this drug-use effect resulted from the spread of sleep behavior from one person to another. Mednick et al.'s results also showed that adolescents who were most centrally located in the social networks they analyzed were not only the most influential, but also at highest risk for

poor health outcomes with regard to sleep and drug use. Although this study is the first of its kind, it is clearly an important area requiring further research.

Other negative effects of sleep loss may not be as dramatic as psychological problems or substance abuse, but they directly impact teens' day-to-day functioning. Adolescents suffering from inadequate sleep have been observed to demonstrate less control over their mood, reacting in a more extreme way to humorous, frustrating or sad situations.

Impulse control is also impaired by inadequate sleep (Dahl and Lewin, 2002). According to Dahl, well-respected researcher in the area of child and adolescent development and sleep,

“Human sleep deprivation impairs PFC [prefrontal cortex] functions, resulting in less executive control. This translates into decreased goal directed behaviors and diminished cognitive modulation of drives, impulses and emotions. The highest or most complex level of waking integration, such as simultaneous cognitive, emotional, and social challenges, appears to be the most sensitive to sleep deprivation effects.” (Dahl, 1996 p. 16)

One very real consequence of sleep loss for teens may be lower grades. The ability to concentrate and pay attention are adversely affected by poor sleep (Dahl and Lewin, 2002; Roberts et al., 2002), as are performance on various types of tasks, including those that simulate academic situations (Curcio et al., 2006; Sadeh et al., 2003). These difficulties may translate directly into poor grades for teens who sleep too little. Wolfson and Carskadon (1998), in a survey study of more than 3000 Rhode Island high school students, found that adolescents who described themselves as struggling or failing in

school (earning C's, D's and F's) obtained about 25 minutes less sleep and went to bed 40 minutes later than A and B students.

Other short-term consequences of inadequate sleep that are rarer, but still important are increased risk of illness (Irwin, 2002; Lange et al., 2003), injury or death, particularly from motor vehicle crashes (Dahl, 2008). Lange and colleagues found that among two groups given a Hepatitis A vaccine, those who slept normally following the vaccination had antibody titers that were nearly twice as high 4 weeks later as those in the group that stayed awake overnight following vaccination (Lange et al., 2003). Irwin reported that experimentally induced partial sleep loss negatively affected immune factors such as interleukin-2 and natural killer cell production (Irwin, 2002). Dahl asserted, in a review of adolescent developmental and neurobehavioral processes that impact driving, that sleep deprivation “(e.g., 18–24 hours of continuous wakefulness) creates impairments in attention, reaction time, and judgment at levels that are comparable to being legally intoxicated with alcohol.” In addition, he points to growing evidence that “the majority of drowsy-driving–related crashes are caused by drivers who are aged < 25 years” (Dahl, 2008 p. S282).

All of these short-term effects of sleep loss are critical, because as teenagers move through their adolescent years, they generally sleep less and less. Wolfson and Carskadon (1998), in the study described above, documented a drop in self-reported total

sleep times (both weekday and weekend) of 40-50 minutes across ages 13 to 19. This was due to later bedtimes for older teens, while rise time remained relatively consistent.

Evidence for long-term consequences of inadequate sleep for adolescents

Several researchers have addressed the relationships between inadequate sleep in adolescence (specifically insomnia) and the development of psychological problems, especially depression, later in life. Roberts and colleagues (2008) surveyed over 4000 youth aged 11 to 17 about their sleep and followed up with over 3000 of them 1 year later. Multivariate analysis revealed that chronic insomnia increased subsequent risk for somatic health problems, interpersonal problems, and psychological problems, including depression. Roane and Taylor (2008), examining data from Add Health in 1994 and 1995 and following up with more than 3500 young adults 6 to 7 years later (2000-2001), found that after controlling for gender and baseline depression, adolescent insomnia was a significant risk factor for young adult depression (odds ratio 2.3).

Substance abuse has also been linked to sleep problems earlier in life. Wong and colleagues have conducted a series of studies with children at risk for alcohol and other substance abuse problems (because of paternal alcoholism), starting at age 3-5 and continuing to the present, when these young adults are aged 18-20. Controlling for parental alcoholism, they found that maternal reports of child overtiredness at age 3-5 predicted onset of any use of alcohol, marijuana and illicit drugs by age 14 in 257 boys (Wong et al., 2004). In a later report, including 292 boys and 94 girls, they found that

sleep trouble and overtiredness at 3 to 8 years of age predicted the onset of alcohol, cigarette and marijuana use among boys and alcohol use among girls in adolescence (Wong et al., 2009). Although these authors did not find links between sleep measures taken in adolescence and young-adult alcohol outcomes, they did find that overtiredness at age 3 to 8 significantly predicted all tested alcohol outcomes, including binge drinking (OR 2.8), blackouts (OR 2.0) and driving while under the influence of alcohol (OR 2.3) (Wong et al., 2010), indicating relationships between sleep and substance abuse that may be set in motion even before adolescent sleep issues begin.

As discussed later in this chapter, inadequate sleep has been associated in cross-sectional studies with increased body mass index (BMI) (Gangwisch et al., 2005; Hasler et al., 2004; Noland et al., 2009). Body changes in glucose metabolism in response to short sleep may lead to a longer-term problems with overweight or obesity and diabetes mellitus (Spiegel et al., 2009). In addition to raising risk for psychological problems, substance abuse, overweight and endocrine problems, poor sleep patterns in adolescence have the potential to lead to poor sleep patterns in adulthood (Calamaro et al., 2009). In addition, although longitudinal studies have not yet tested this hypothesis, researchers posit that inadequate sleep at critical developmental junctures could lead to alterations in brain wiring (Dang-Vu et al., 2006), especially within the prefrontal cortex for adolescents (Dahl and Lewin, 2002).

Context of short term coping behaviors to address inadequate sleep

Compared to knowledge about negative short and long term consequences of inadequate sleep, less is known about how the adolescent body copes with not sleeping enough (sleep loss) and with the accumulating “tally” of lost sleep stored by the body (sleep debt). Even a cursory look at sleep in the United States often reveals a disparity between the amount of sleep needed to produce a fully functioning human being, and the amount of sleep the typical individual obtains. For example, to calculate a general “sleep need” figure for adolescents, researchers at Stanford University started a study in 1976 where they invited children who were 10 to 12 years old to come into their sleep lab and sleep several nights each year for 5 or 6 years. They asked the children and adolescents to sleep 10 hours a night for the week before the study, and then they measured how much the participants slept between 10 pm and 8 am in the lab for three consecutive nights. They thought that as these preteens got older, up to 15, 16, or 17 years old, they would need less sleep, and therefore sleep for less of the 10 hour window. But this turned out not to be true. No matter the child or adolescent’s age, they all slept for about 9 hours 15 min when given the opportunity. (Carskadon, 1999). Therefore, it is likely that individuals have developed strategies for coping with inadequate sleep, changing their behavior, and perhaps even cultural norms, to continue operating as “normally” as possible in their sleep-deprived state.

Given the continual sleep decline experienced across adolescence, and the negative consequences associated with insufficient and disturbed sleep, one might expect to find a

large literature on how adolescents might cope with sleep loss or poor sleep. However, only one published article directly addresses this topic. Yang and colleagues (2003) surveyed nearly 2,000 first-year college students in Taiwan, and found that more than 40% reported some problem with their sleep. The most common problem, among both males and females, was insufficient sleep. Their questions on coping with sleep problems revealed that taking naps and adjusting sleep schedules were the most effective strategies, while engaging in a sleep-promoting activity (such as counting sheep) or ignoring the problem were largely ineffective. Strategies did not differ significantly by gender, though females were slightly more likely to take naps and males slightly more likely to ignore the problem (Yang et al., 2003). To date, comparative research on this topic has not been conducted in the U.S.

The present research examines several ways that adolescents may cope with inadequate sleep, including napping, adjusting sleep timing, altering overall caloric intake, altering fat or caffeine intake, or changing their physical activity level. Each of these behaviors is embedded in, and has consequences for, the biological, cultural and environmental spheres that affect adolescent sleep. For example, napping and adjusting sleep timing may be either easy or more difficult for an individual based on their normal sleep pattern. Even if a teen is tired and wants to nap, or go to bed early, their normal sleep pattern, driving their circadian rhythm, may preclude sleep at a time when they normally expect to be alert. Napping for more than 30 minutes may also negatively affect adolescents' performance on tasks, because of the sleep inertia and associated performance slowing

detected on waking from a nap (Dhand and Sohal, 2006; Hofer-Tinguely et al., 2005). Napping and changing bedtimes and wake times also have a cultural component. Napping may be under-valued, as it often is in the U.S. (Baxter and Kroll-Smith, 2005), where it may be seen as an expression of laziness. Going to bed early may be viewed by parents as unwise (if the teen has a project to finish or a test to study for) or by friends as uncool (indicating that the teen values sleep over communication with friends, for example. Environmental factors may also affect napping and sleep timing – it may be too light outside to fall asleep, or the technology environment may beckon with greater perceived rewards (Worthman, 2008) than the potential of feeling more rested the next day.

Altering food or drink intake has its own set of biological, cultural and environmental constraints. Consuming additional food may cause one to gain weight, be viewed differently by friends, or seek to break rules set up for the high school environment (by, for example, eating in class or leaving the closed campus to buy food). High caffeine consumption has recently been linked to poor bone mineral content and strength in German children and adolescents (Libuda et al., 2008). In addition to this potential long-term effect, short-term effects of caffeine include both positive effects, such as fighting fatigue and improving problem-solving abilities, and negative ones like increased anxiety, jitters, heart palpitations, stomach pain and gastrointestinal reflux (Shute, 2007). One study examining simultaneously intake of caffeine and taurine (a combination found in many energy drinks) found that this mixture had no impact on short-term memory, but

provoked a drop in heart rate and a rise in blood pressure (Bichler et al., 2006). Socially and environmentally, caffeine consumption may be encouraged in certain situations (for example, when friends are drinking caffeinated sodas) or discouraged in others (if teens are not able to leave campus to buy soda, or teachers discourage its use in class or during after-school activities). Finally, coping with inadequate sleep by reducing physical activity, although it provides the body an opportunity to rest, may be viewed negatively by physical education teachers or coaches, who give adolescents lower grades for non-participation.

Impact of short sleep on food intake, caffeine intake, and physical activity levels

As discussed above, studies of sleep have relevance both at an evolutionary time scale as well as the shorter months, weeks or days it may take to make behavioral changes that enable the individual to cope with acute sleep loss, or attempt to reduce or eliminate sleep debt accrued from chronic sleep loss. The shortest time scale of days is also of interest when investigating another question of interest in this research; namely, whether a relationship between sleep and food intake can be discerned and described in a sample of adolescents keeping short-term sleep and food diaries.

Even before biological mechanisms were well-explored, lack of sleep was linked with obesity in humans, with several cross-sectional studies showing that the less sleep an individual gets, the higher the risk that they will have an increased body mass index value (Gangwisch et al., 2005; Hasler et al., 2004). This relationship has also been upheld recently in a questionnaire study of sleep in high school students (Noland et al., 2009).

In a number of lab studies, short sleep (typically 4-5 hours per night and lasting 2-3 days) has been linked to a drop in the appetite-regulating hormone leptin and a corresponding rise in the hormone ghrelin (Copinschi, 2005; Spiegel et al., 2004; Taheri et al., 2004; Van Cauter et al., 2008). Dysregulation of these hormones leads to increased feelings of hunger, for all food groups except meat and dairy (Spiegel et al., 2004) but this did not translate into additional food intake in the lab because study participants were fed a set number of calories. In the real world, however, this increased hunger could lead to increased food intake, and an increased potential for overweight and obesity, which are associated with a variety of illness complexes. Most studies that explore this phenomenon do not break down their sample by gender; if their sample includes both men and women they simply control for gender during statistical modeling.

Recently, several articles linking sleep and energy metabolism have been published, expanding the sleep and food intake literature and reflecting increasing interest in links between short sleep and obesity. These papers discuss both humans and nonhumans, and studies that occurred in both laboratory and “free-living” (large, cross-sectional epidemiological) settings. Knutson and colleagues (2007), in a review paper, find suggestive links between chronic partial sleep loss (the type of sleep loss, as opposed to total sleep deprivation, most likely to affect American adolescents) and increased body weight. They posit three mechanisms by which this weight gain may occur. First, curtailed sleep may alter glucose metabolism. The authors note the similarity of insulin and glucose values in healthy young men who had been sleep-restricted (4 hours in bed

per night) for 5 days to older adults with impaired glucose tolerance. Their results also suggest that insulin resistance, a known risk factor for type 2 diabetes, may “develop progressively with increasing exposure to partial sleep loss” (Knutson et al., 2007 p. 166).

Second, sleep may be linked to appetite, specifically the appetite-regulating hormones leptin and ghrelin. Under normal conditions, leptin, secreted by adipose tissue, inhibits appetite, and ghrelin, released from the stomach, increases appetite and food intake. Ghrelin is suppressed after food intake and rebounds 1.5 to 2 hours later. Most studies that have measured leptin and ghrelin levels have been lab-based, meaning that food intake by participants was limited by lab protocols. Knutson’s exploration of the leptin and ghrelin literature concludes with a call for studies that “examine actual food intake under different sleep duration conditions” (Knutson et al., 2007 p. 170), a challenge undertaken in part by this study.

A final contributor to the link between reduced sleep and weight gain lies in reduced energy expenditure. While it may seem logical that individuals who are tired might be less likely to participate in physical activity, particularly vigorous physical activity, several studies have quantified this relationship. Gupta and colleagues (2002), in a study of 11 to 16-year-old adolescents using wrist actigraphy, found that sleep disturbance, but not total sleep time, was inversely associated with daily physical activity, more strongly in girls than in boys. For every hour increase in sleep disturbance, adolescents’ daytime

physical activity, measured as average actigraph activity counts during non-sleep minutes, diminished by 3%. Several studies have also shown that individuals with sleep problems and/or excessive daytime sleepiness “report a significant reduction in their levels of physical activity and energy” (Knutson et al., 2007 p. 174). The present study enables comparison among sleep, food intake, and activity levels in adolescents by providing quantifiable links between sleep and food intake, while also considering physical activity. This study also incorporates results from interviews where youth were asked to discuss their perceptions of how sleep and both quantity and quality of food intake might be related.

An important corollary to the study of sleep and food intake is a focus on caffeine and other items designed to increase alertness. Social historians have written about how stimulants and intoxicants rose in popularity from around 1700 on (Schivelbusch, 1992) and anthropologists have documented how drug foods (the most common of which are cacao, coffee, tea, tobacco distilled alcohol, sugar and opium) were historically used as “labor enhancers” (Jankowiak and Bradburd, 1996). While collecting measures of “productivity” in teens that may be correlated with caffeine use is beyond the scope of this dissertation, I will focus on the biological and social impacts of caffeine use in this teen population.

The social environment of caffeine use in the context of widespread sleepiness is clearly relevant in the lives of teens. Studies indicate that caffeine use is widespread in

adolescents, with several studies reporting that between 70 and 90% of high school students consumed caffeinated beverages or foodstuffs on a given day (Reid et al., 2002; Valek et al., 2004). Along with the explosion of personal technology detailed in the next section, caffeinated beverages as a sector of the beverage market have also experienced great growth in recent years. Reissig and colleagues (2009) trace this caffeine increase back to the introduction of energy drink Red Bull to the U.S. in 1997. Between 2002 and 2006, the average annual growth rate in energy drink sales was 55%. In 2006, 500 new brands were launched worldwide, and 200 new brands were launched in the U.S. alone between July 2006 and July 2007. Although some brands have a “modest” 50 milligrams of caffeine per can or bottle (20 ounces of the “Citrus energy” flavor of Vitamin water, comparable to 12 ounces of Mountain Dew, the highest-caffeine soda), some have up to 505 mg in a 24-ounce bottle (Wired X505). These drinks are primarily advertised to young people, especially males, and Reissig and colleagues suggest that they should come with warning labels, such as, “For occasional use only. Not intended for use as a substitute for sleep. If fatigue or drowsiness persists or continues to recur, consult a doctor” (Reissig et al., 2009 p. 3). Few studies have examined the relationship between caffeine consumption and sleep patterns (but see Calamaro et al., 2009 for an important exception). This study will be the first to seek associations among food intake (including fat and caffeine intake) and sleep using detailed diary records from a small cohort of adolescents.

Culture and sleep behavior

Sleep in Western societies: embodied, negotiated, healthy, or under the medical gaze

Sleep, like food, shelter, and sex, is a biological need, but it is also a “cultured” practice of the body. Sleep is socially prescribed and culturally patterned (Williams and Bendelow, 1998). Although research has examined the “doing” of waking activities, gaps remain in the investigation of “doing sleep,” including social prescriptions (where does one sleep? with whom?) body techniques (how does one fall and stay asleep?) and temporality (when is an appropriate time to go to sleep and to get up?). There are also unanswered questions about the consequences of inadequate sleep, especially as perceived by the sleeper. Culture is learned, internalized and naturalized (Williams, 2002), and it is clear that “how to sleep” is part of one’s cultural schema, albeit a relatively unexplored part. Little is known at present about how children are socialized to sleep, and the extent to which familial patterns affect youth sleep, especially given the proliferation of individual media devices which potentially permit each family member to engage in a different activity, even while sharing the same physical space.

Embodiment and negotiation

Meadows (2005) typology of embodied sleep, introduced in Chapter 1, is a useful way to approach the study of sleep from a biocultural perspective. By investigating *pragmatic embodiment*, this research explores how teens conceptualize, and act on, “sleeping like a teenager.” The *experiential embodiment* of sleep, or teens’ feelings about their sleep, in tandem with the messages they receive from others and environmental constraints such as

school start times, help shape their ideas of culturally appropriate sleep. This combination of factors helps teens decide when to go to bed, when to get up, and which environments (using technology vs. a quiet room, for example), rituals, and body techniques offer the best way for them to fall asleep, stay asleep, and wake in the morning.

In their study on men's attitudes toward sleep, Meadows and colleagues (2008) focus on how sleep reflects negotiation between role expectations and desired goals. Men want to sleep enough to function well in their roles as workers, fathers and mates, but also limit sleep in order to pursue valued goals, like enjoying time at home in the evening after a long work commute. This negotiation is also evident in adolescent lives among both males and females in my study, as teens strive to embody their roles as students, athletes, etc. but also maintain their social identities both through in-person and on-line communications.

Another type of negotiation around sleep is documented by several groups of anthropologists writing about co-sleeping, that is, room or bed sharing between parents and babies and/or children, generally viewed by the medical community as a dangerous, "cultural" behavior often associated with low socioeconomic status that can lead to infant death.² These biological anthropologists and their colleagues seek to present co-sleeping

² See Davis et al. 2004, however, for a few cautionary words about applying American cultural values to co-sleeping. Also worth noting here is that although cosleeping has been "traditionally" associated with lower socioeconomic status (SES) and non-white ethnicity, the "attachment parenting" method both encourages cosleeping and has been often embraced by higher SES, white parents. (Sears W, and

as a “natural” human behavior engaged in by most of the world outside the United States (Ball and Moya, 2009; McKenna and Volpe, 2007; Mosko et al., 1997).

Two published studies have addressed the negotiation of sleep in cultures outside the West, one in Egypt and one in Japan. In Egypt, Worthman and Brown focused on family sleep patterns and sleep quality in Cairo, where cosleeping, either bed or room sharing, with 1 to 4 other family members was a very common occurrence (almost 70% of recorded sleep events). Individuals slept better (longer duration, fewer arousals) when cosleeping rather than engaging in solitary sleep (Worthman and Brown, 2007). Another cultural study was conducted by Steger, a specialist in Japanese studies and sociology, who examined the paradox of Japanese adolescents who stay up late at night to study, but then sleep during daytime classes. Daytime napping, or *inemuri*, is not seen as sleeping due to laziness but instead regarded as needed sleep in response to the exhaustion brought on by “working hard” and studying late at night. Because Japan is an “educationally credentialed society...belonging to a certain institution is of critical importance” (Steger, 2006 p. 204). Therefore, Steger concludes, if you attend the right school, and study hard at night to pass exams to get into the right university, sleeping in class is beside the point.

Sleep and health

Meadows’ *normative embodiment* focuses on definitions of “healthy sleep.” To determine what is healthy, however, it is useful to define “illness” Noted medical

Sears M (2001) *The Attachment Parenting Book: A Commonsense Guide to Understanding and Nurturing Your Baby*. New York: Little Brown and Company.)

anthropologist Eisenberg defines this term as “experiences of discontinuities in states of being and perceived role performances” (Eisenberg, 1977 p. 9). By this definition, however, generalized sleep problems (e.g., not getting enough sleep and feeling tired) are not likely to even be classified as “illnesses” in the United States. We tend to be so sleep deprived (Bonnet and Arand, 1995) that feeling sleepy, especially for teens, is not noted as a “discontinuity” in a state of being, it generally *is* our state of being.³ Sleepiness has been normalized. Sleep deprivation as a departure from health generally does not become an illness until symptoms become more severe, such as with insomnia. Even with recurrent insomnia, individuals may just cope with this symptom set and not seek medical help (Hauri, 1994).

In one of the few qualitative studies of sleep perceptions and behaviors, Hislop and Arber draw on the theoretical work of Williams (2005). He has sought to understand how sleep encompasses both culture and biology by exploring the effects of medicalization, “healthicization” and personalization on sleep. Medicalization advances biomedical causes and treatments for often newly-defined medical “problems.” Healthicization of sleep, on the other hand, does not depend upon the use of a medical framework or medical treatment. Instead, healthicization targets sleep as a health behavior that can be improved by lifestyle changes and behavioral interventions (Williams, 2002). In this view, sleep and health have a reciprocal relationship, and behaviors that promote health,

³ I make this broad statement – however, it is worth noting that although the National Sleep Foundation (NSF) “Sleep in America” polls do include individuals across a range of ages and of both genders, their adolescent poll from 2006 shows 61% of their respondents were white, and they did not sample on any sort of social class measure. Among smaller sleep studies, the variety of ethnic and social class distinctions potentially available in the US are generally poorly represented.

such as a balanced diet and physical activity, may also promote better sleep. Finally, personalization is a process of making personal decisions to improve one's own sleep. This process may also encompass the development of specific routines and rituals to improve sleep, and to compensate for lack of sleep (Hislop and Arber, 2003). In their qualitative study of women over 40, Hislop and Arber argue that their participants tended to use either a healthcization strategy (making lifestyle or behavioral changes to improve sleep) or personal strategies to cope with their sleep loss and avoided using medical terms for their sleep problems. Although they did not see sleep loss as desirable, these women were likely to use alternative remedies to help their sleep, and to avoid prescription pharmaceuticals.

The medical gaze

Most people who study sleep are trained as psychologists and psychiatrists; the “academic home” of sleep study is often the psychology department. These researchers are often concerned with medically diagnosable sleep disorders (Morin et al., 2006; Morin et al., 1999), and only tangentially with an individual's perception of their own sleep. Sleep perceptions often appear in this medical/psychological literature as “sleep mis-perceptions” experienced by insomnia sufferers. While objective recording of sleep shows the quantity and quality of individual sleep, insomniacs typically feel that they sleep much less and/or much worse than the objective measure states (Morin et al., 1993; Pinto et al., 2009).

In an effort to investigate sleep perceptions among persons diagnosed with a sleep disorder, two medical anthropologists write about sleep from inside the sleep medicine community. Henry and colleagues have elicited explanatory models of insomnia from individuals (Henry et al., 2008), while Wolf-Meyer engages in a complicated theoretical analysis of the separation of and abstraction of “sleep disorders” from the body under the gaze of physicians and the National Sleep Foundation, drawing on actor-network theory and medical semiotics (Wolf-Meyer, 2008).

A new development in the nascent theory of sleep and culture over the last five years has also been the rise of the “sleep industry” (also referred to as the “sleep industrial complex” (Mooallem, 2007)). Likely spurred by the medicalization of sleep, the industry offers both pharmacologic and non-pharmacologic sleep aids. Newspaper articles proclaim the tenets of good sleep hygiene, while mattress-makers and sellers push their wares as the best way to restful sleep (witness the rise of the “Sleep-Number Bed,” with adjustable firmness on each side of the bed so that couples with differing bed preferences may be well rested in the same bad, now heavily advertised on TV and in print. Direct-to-consumer television advertisements tout free samples of Lunesta (and other brands of sleeping pills) and encourage viewers to “ask your doctor if Drug X is right for you” because “your dreams miss you.”⁴

⁴ This tag line is from an often-played commercial series in 2007 and 2008 for Rozerem, a sleep aid produced by a Japanese pharmaceutical company. It features a sleepy-looking guy padding around his kitchen and running into Abe Lincoln and a beaver playing chess at his kitchen table. They complain they have not seen him for a while and encourage him to take medication because “your dreams miss you.” See the 1-minute commercial online at: www.youtube.com/watch?v=wdpOlaGnzvA

Sociologist Kroll-Smith has observed the “sleep-industrial complex” and seeks to both theorize and demonstrate the intersection of sleep, modernity and medicalization. Specifically, his concern is with perceptions of sleep in the media, especially excessive daytime sleepiness (EDS). He argues that EDS has moved from being a symptom of long-recognized sleep disorders such as narcolepsy or sleep apnea to being a dangerous “illness” in its own right. In a 2003 review, he tracks media representations of daytime sleepiness, finding that print, video and online media have contributed to – and co-created – increasing awareness of and anxiety around the potential dangers of EDS. While EDS has become medicalized, he says, the move toward recognition and treatment of EDS is not primarily due to the efforts of the medical establishment (i.e., this has occurred outside of Foucault’s institutional “panopticon” (Foucault, 1979). Today, however, it seems that the medical establishment is seeking to co-opt EDS back into the Panoptical institution by encouraging individuals to heed news articles and their internet search results and talk to their doctor about pharmaceutical sleep aids. In the last two years, anthropologists and sociologists have followed up on Kroll-Smith’s work, looking more specifically at the “pharmaceuticalization” of sleep in everyday life, especially through direct-to-consumer (DTC) advertising in the U.S. and newspaper articles in the UK, where DTC advertising is not allowed (Williams et al., 2008; Wolf-Meyer, 2009). To give an idea of the extent of commodification of sleep (including but not limited to pharmaceuticals), an online press release for a market study of “the U.S. Sleep Market,” designed to offer a little data (and encourage the reader to buy the entire report for \$1,895), reports that the U.S. sleep market was worth \$ 23.7 billion in 2007, including

sleep disorder diagnosis, sleeping pills and sales of sleep hygiene items from mattresses to “high tech pillows” and more. In 2007, the major producers of sleeping pills (chiefly Lunesta, Ambien and Rozerem) spent \$ 619 million to advertise their products, resulting in \$ 2.7 billion in sales. The sale of continuous positive airway pressure (CPAP) machines, a treatment for sleep apnea, was a \$ 2.4 billion market in 2007, but it was dwarfed by the \$13.7 billion retail mattress market (working in concert with the \$900 million pillow market) (Marketdata Enterprises Inc., 2008). While few adolescents take medicine to help them sleep, the DTC advertisements do reach adolescents, who often incorporate them into their views about sleep⁵. When I asked where students got their ideas about sleep, a few specifically mentioned ads for Lunesta and Rozerem. And when I asked one student at the end of our interview about sleep if she had any questions for me, her question was, “What is the sleep number bed?”

Impact of time famine and flexible accumulation on sleep

In addition to contributing holistic, empirical studies of sleep, anthropologists also contribute theoretical constructs that are useful for analyzing the broader interplay of work and rest in American culture. Ideas of time famine (de Graaf et al., 2005; Vuckovic, 1999) and an idea of flexible accumulation (Harvey, 1989), borrowed from economics, are likely to affect youth perceptions of sleep, and sleep behaviors as well. Time famine refers simply to the idea that there is not enough time in the day to do

⁵ Although it is beyond the scope of this dissertation to analyze the effect of DTC advertisements on teens' sleep knowledge, the reader is referred to Briggs and Hallin's excellent 2007 article as a starting point for further investigation of this phenomenon (Briggs CL, and Hallin DC (2007) Biocommunicability: The neoliberal subject and its contradictions in news coverage of health issues. *Social Text* 25:43-66.)

everything that an individual wants or needs to do. Flexible accumulation is defined by anthropologists as “the need to rapidly retool and restructure in response to constant and immediate feedback” (Vuckovic and Nichter, 1997 p. 1289). Emily Martin also writes about flexible accumulation (which she calls flexible specialization) as a political-economic shift that affects perceptions of the body (Martin, 1994). In practice, flexible accumulation implies that both adolescent health behaviors (including sleep) AND their perceptions of what it takes to be healthy may be continually restructured to cope with a rapidly changing world. In response to inadequate time to learn and practice new skill sets, adolescents may sleep less. This may result in them making behavioral changes – or changing their attitudes - to cope with inadequate sleep. Documenting teen behaviors and perceptions enables analysis of how adolescents begin to manage necessary biological and social trade-offs in their lives around the particular health behaviors of sleep, food intake and activity patterns.

In 1995 Bonnet and Arand wrote a paper for the journal *Sleep* entitled “We Are Chronically Sleep Deprived.” By “we” they mainly meant Americans, both adults and adolescents. Despite of their conclusion that “significant sleep loss exists in one-third or more of normal adults” (Bonnet and Arand, 1995 p. 908), little if any public outcry occurred. We just seem to accept sleep deprivation as a consequence of American life – with a constant focus on productive activity, doing more, and getting more, sleep falls by the wayside. De Graff and colleagues note that sleep loss is a symptom of what they term “Affluenza,” the continual desire for more (de Graaf et al., 2005). By the 1990s, they

note, trend-spotters were already aware of a looming specter of time famine. This term refers to the constant “busy-ness” experienced by individuals as the pace of life increases. While increases in technology were supposed to result in less work, exactly the opposite has happened, with Americans now working *more* than a generation ago. Full-time American workers are in fact working one full month more, on average, than they did in 1969 (de Graaf et al., 2005; Schor, 1993). With more work, something has to give – and often it’s sleep. “Many doctors say that more than half of all Americans get too little sleep – an average of an hour too little each night. We average 20 percent less sleep than we did in 1900” (de Graaf et al., 2005 p. 44-45). The National Sleep Foundation, which conducts annual “Sleep in America” polls with different targeted populations (adolescents one year, workers the next) also agrees with this assessment and illustrates it year after year with shocking statistics on how little Americans sleep. Although researchers have begun to investigate the negative impacts of this overall American decline in sleep time, much longitudinal work still remains to be done, especially with adolescents, whose growth and development may be adversely affected by diminished sleep.

The culture of adolescent sleep

Few researchers have studied sleep from a layperson’s perspective, either in adults or in adolescents. Little is known about the number of hours of sleep people believe that they need, how individuals manage their sleep, or how they conceptualize what happens to them physiologically, psychologically and emotionally after a night of too little sleep.

Such perceptions of sleep influence sleep behaviors, along with other biological, social and environmental factors at play in the lives of teens. This dissertation aims to address this gap in knowledge of adolescent sleep perceptions and behaviors by exploring social and environmental factors that both shape perceptions and affect sleep behavior on a daily and weekly basis, including how these factors interact with biological realities of teen sleep. Only two studies, one in public health and the other in pediatrics, address how young people think about their own sleep as part of an examination of youth sleep. Noland and colleagues (2009) investigate adolescents' sleep behaviors and perceptions of sleep in Ohio, using a comprehensive questionnaire, while Owens and colleagues (2006) report results from interviews with middle-school students in Rhode Island. These two studies will be described in more detail in Chapter 4, where their findings may be compared more directly with findings from this study, based on interviews with teens and participant observation in the high school.

Environmental influences on sleep behavior

Sleep constraints imposed by high school

In the 1990's, some researchers began writing more about how environmental variables, such as school start times, limited teen sleep in concert with biological variables. In addition to physical changes in sleep that teens experience during adolescence, school schedules often demand that adolescents wake early, cutting off their sleep before they reach the recommended 9.25 hours per night (Carskadon, 1999). A number of studies have shown that adolescent circadian rhythms are "out of sync" with school schedules

(Carskadon, 1999; Carskadon et al., 1998; Wolfson and Carskadon, 1998). One study that monitored adolescents as they returned to school in the fall found that they lost as much as 120 minutes of sleep *per night* in the week after the start of school as they switched from an adolescent-controlled sleep schedule to a school-dictated one (Hansen et al., 2005). Studies that have investigated the impact of changing school start times have found positive effects of later high school start times (Kubow et al., 1999).

The omnipresent technology environment and its effect on sleep

“Today we inhabit a nonstop culture characterized by widespread electric lighting both within and outside homes and businesses. Never before, in our everyday lives, have we been more dependent on artificial illumination, arguably the greatest symbol of modern progress... Darkness represents the largest remaining frontier for commercial expansion. Thomas Edison’s dictum “Put an undeveloped human being into an environment where there is artificial light and he will improve” has carried the night as well as the day... Not surprisingly, sleep, too, has fallen prey to the hurried pace and busy schedules of modern life. In the United States today, perhaps 30 percent of adults average six or fewer hours of rest a night, with that portion rising as more persons stretch their waking hours. Disdaining sleep as a waste of time, many adolescents find their slumber harmed by television, computers, and other sources of sensory stimulation.

A. Roger Ekirch “At Day’s Close: Night in Times Past” 2005, p. 337-338

Technology exerts an undeniable effect on today’s adolescents. According to a recent Kaiser Family Foundation (KFF) report on media use in over 2000 8 to 18 year-olds, young people in the U.S. spend an average of 7.5 hours daily hours per day watching television and movies, listening to music, using the computer outside of school work, playing video games and reading. According to the study’s authors, “given the amount of time they spend using more than one medium at a time, today’s youth pack a total of 10 hours and 45 minutes worth of media content into those daily 7½ hours—an increase of

almost 2¼ hours of media exposure per day over the past five years” (Rideout et al., 2010 p. 2). Across the five years, only time spent using print media declined. In 2009, 76% of these teens and pre-teens owned an iPod or MP3 player, up from 18% in 2004. And 66% owned a cell phone, up from 39% in 2004 (Lewin, 2010). Although 20% of media content is now consumed on mobile devices (cell phone, iPods or handheld video game players), KFF did not specifically track time talking or texting on the cellphone as part of their “media use” calculation. So in addition to the 10 hours 45 minutes, teens are also, on average, talking on the cell phone for 33 minutes per day and texting for 1.5 hours. Far in advance of these shocking media numbers, a leading authority on adolescent sleep speculated that, “access in the bedroom to computers, televisions, telephones and so forth probably contributes to the delay of and reduction in sleep” (Carskadon, 1999, p.349). Only a small number of studies, detailed below, have investigated this claim, though this study will begin to investigate how technology use and sleep interact in a specific high school population.

In 2001, Japanese researchers published a study linking excessive television game-playing among 6 to 11-year-old school children with several negative physical signs, including black rings under the eyes and muscle stiffness in the shoulder. These signs were all significantly associated with sleep deprivation, making the first link between electronic media use and sleep (Tazawa and Okada, 2001). Higuchi and colleagues (2005) subsequently found that after playing a computer game in a lab setting, subjects

had a an elevated heart rate, lower subjective sleepiness, and they took longer to fall asleep than under control conditions.

In 2003, a Belgian communications researcher first noted that text messaging was disturbing the sleep of teens. Analyzing a question added to a larger survey of media use and health in a Belgian secondary school sample administered to 2546 teens, he found that between 6 and 11% of teens were awoken by an incoming text message at least once a week, with 5 to 9% woken up several times a week and 2 to 3% woken up every night. For his analysis, he looked only at first-year students (mean age 13.16 years) and fourth-year students (mean age 16.37 years), with the smaller numbers above representing the younger students and the larger numbers the older students (Van den Bulck, 2003). In 2007, Van den Bulck published a more detailed analysis of mobile phone use, analyzing timing of text messages and calls from teens' self-report. In a sample of over 1600 Belgian secondary-school adolescents, he found that most teens sent text messages (56%) or called (58%) just after lights-out, but up to a fifth sent texts (19%) or called (20%) at any time of the night. These data also showed a robust relationship between the frequency of calling and texting after lights-out and reported tiredness one year later. If a student used their phone more than once a week after lights out to send or receive calls or text messages, they were over 5 times as likely to report being "very tired" during a follow-up survey a year later, indicating a persistent pattern of media use and resultant sleepiness. (Van den Bulck, 2007).

Gaming and texting are not the only technological contributors to poor sleep, however. Johnson (2004) published a longitudinal study directly addressing the relationship between television viewing and sleep problems, concluding that adolescents who watched more than 3 hours of television per day were at increased risk for sleep problems (including difficulty falling asleep and frequently failing to get enough sleep) by early adulthood. In addition, a German study found a significant relationship between shortened sleep time and the duration of daily television viewing in a sample of 137 children with a mean age of 13 years (Cronlein et al., 2007). Van den Bulck (2004) reported that students with access to computer games and the internet in their bedrooms went to bed significantly later on weekday and weekend days. They also often spent less time in bed than students without access to such electronic media, and reported higher levels of tiredness on subsequent days.

In recent years, more articles on adolescent technology use and sleep have been published, and concern about this relationship has also begun to appear in newspapers, magazines and through online news sources (Reuters, 2007). Olds and colleagues (2006) documented “screen time” as part of the time budgets of Australian children between the ages of 10 and 13. Screen time in this study included television, video games, non-game computer use, and watching movies. They found that the top quartile of “screen users” were more likely to be boys, have low physical activity, spend > 25% of their screen time playing video games, sleep less, and be of lower socio-economic status. An article entitled “Nodding off or switching off?” documented the common practice of adolescents

using media such as TV, computer games, music and books as sleep aids (Eggermont and Van den Bulck, 2006). These authors concluded that while reading books to fall asleep was associated with sleeping more, use of the TV, a computer game, or music to fall asleep was associated with less sleep among adolescents.

Some of the technology effects on sleep come from exposure to bright screens shortly before bedtime. A study by Higuchi and colleagues (2003) linked their participant's sleep difficulties (normal decrease in body temperature, and melatonin secretion, both of which aid in falling asleep, were both suppressed) to screen brightness. A more recent study by Dworak (2007) found that children who played computer games before bed took longer to fall asleep, and experienced less slow-wave-sleep (the deepest, most restorative sleep), while children who watched TV before bed showed reduced sleep efficiency, sleeping in a less-consolidated way.

Putting it all together: the contribution of this work to sleep scholarship

This study adds to the adolescent sleep literature by presenting a detailed picture of sleep in a cohort of 50 high school students. Unlike many studies, mine follows the same cohort across a calendar year, collecting data at three time points, and including weeknight sleep, weekend night sleep, and summer sleep. The studies discussed above in the short-term consequences section, by Fredriksen and Wolfson and Carskadon, represent some of the most comprehensive studies of adolescent sleep in real-world settings, but both are based on surveys completed by teens. This is critical because what

teens report on a survey may or may not match up with the sleep they report on a daily diary, and this, in turn, may complement or contradict what a researcher may discern from talking with teens about sleep and observing them during a typical day. In addition to collecting data on sleep behaviors and perceptions from multiple sources, this work also documents ways in which adolescents make behavioral changes to cope with inadequate sleep, including changing sleep timing, food intake, and activity levels. Though sleeping, eating, and being active have undeniable biological consequences, cultural ideals shape the execution of these behaviors on a daily basis. In addition, this research incorporates the technology environment often inhabited by today's teenagers. At present, no qualitative studies have been conducted to explore how sleep represents an intersection of culture, biology and environment in the lives of youth.

The use of a biocultural theoretical perspective that privileges the effects and interactions of biological, social and environmental influences on sleep fits very well with a notion of embodied sleep introduced in Chapter 1. Embodiment recognizes that biological, cultural and environmental influences all play out at the site of the physical body. In a simple example for sleep, a teen may feel physically tired due to her biological sleep drive, but activities like watching a TV show or chatting online might cause her stay awake. She may not feel fatigued at this time, because of her mental engagement in the rewarding activity. In the morning, the environmental influence of the standard school wake-up time, signaled by her alarm or her parent knocking on her door, leads her to wake up tired, and feel sluggish and uninterested in what the day has to offer...until she engages

in social interactions with friends and is magically “not tired” anymore. Meadows’ (2005) typology of embodied sleep is not a radically new way of looking at sleep. In fact, other authors who discuss embodied sleep (for example, Williams et al., 2007) use this typology without explicitly referencing it, because thinking of sleep in terms of how it makes one feel (experiential) and what purpose it serves for a specific individual (pragmatic) are common ways to approach the anthropological question of “How does sleep fit – or not fit – into your daily life?” This study addresses all four elements of Meadows’ typology by integrating how teens learn and internalize information about sleep, how they cope with inadequate sleep by changing their subsequent behaviors and discourse, how they report sleeping too much or too little makes them feel, and how their bodies sometimes demand that they sleep, even under inappropriate circumstances.

Overlaying this perspective of embodiment is the point of view provided by Williams and colleagues (Hislop and Arber, 2003; Meadows, 2005; Williams, 2002; Williams, 2005). These researchers examine sleep as a health behavior that may be co-opted by both individuals, through strategies of personalization, and institutions, through healthcization and medicalization. With healthcization, individuals are told, subliminally or directly, that improving sleep is a good way to improve one’s health. In medicalization, which grades nicely into the sleep industrial complex (Mooallem, 2007), individuals are told by institutions, often the “medical establishment,” that medication and other products are available to treat all their sleep problems – even the ones that they were not sure they had.

This new synthesis for sleep studies, including the perspectives of embodied sleep, the sociology of sleep as a health behavior, and reflections on the sleep industrial complex, advances research on sleep. While the study of sleep has mainly been focused on sleep disorders and other biological/biomedical aspects of sleep, this new perspective allows an investigation of social and cultural aspects of sleep, something that has been largely neglected in the literature (Worthman and Melby, 2002). By looking at the body as shaped and affected by society as well as the natural environment, and health as defined both socially and physically, sleep may be better understood as an interaction of culture and biology rather than in primarily biological terms. Together, these approaches allow me to begin to sketch out a complete picture of how biology, culture, and social and natural environments have interacted to produce the variation in sleep and coping mechanisms to deal with the lack of sleep that we see in modern adolescents.

CHAPTER 3: RESEARCH DESIGN AND METHODS

This chapter will present the overall research design and basic demographic characteristics of the adolescent study participants, followed by the methods used to address my five specific research questions. In addition, I have included an in-depth “methods reference,” where all of my methods are briefly outlined (**Appendix A**).

Research Design

Location

I conducted my research at a large (3000+-student) public high school located in Tucson, Arizona. Tucson is a Southwestern city with a metropolitan population of over 750,000. With 2000 census estimates placing the Hispanic and Latino-origin population at approximately 36% of the total population, Tucson is on the forefront of demographic changes that are beginning to affect the entire nation. In addition to its demographic heterogeneity, the school in which I conducted my study is a magnet school, drawing students from across the metropolitan Tucson area, making it easier to recruit an ethnically diverse sample, and also participants of varying socioeconomic status (SES). Although I did not set up any SES criteria for inclusion or exclusion in the study, I hoped, by including students of varying ethnicities, genders and activity levels, to be able to observe, collect data from, and comment on a broad cross-section of adolescent lives within one high school.

Approvals

Before entering the high school for research purposes, my research plan was approved by the Institutional Review Board at the University of Arizona and the school district research office. My entry into the school was facilitated by the vice-principal for curriculum, who approved my project and asked freshman science teachers if they would be willing to have me in their classroom. Three agreed, so I worked directly with these three teachers, who together taught approximately 450 students, 53% of the freshman class for the 2006-2007 school year. Two teachers taught Integrated Science to freshman (the “typical” freshman science class) and one taught Conceptual Physics to freshman (the “honors” freshman science class).

Sampling

Table 2: Initial conceptualization of sampling

Male and Female 9 th graders (14-15 year-old adolescents)		
	High Activity* (daily or almost daily participation in a sports team practice or individual workout)	Low Activity* (rare participation in sports or individual workouts)
White*	10	10
Hispanic*	10	10

*Ethnicity and activity status were determined by student self-report.

I initially selected the sample size of 40 to ensure that members of Tucson’s largest ethnic groups (White, mainly of European descent, and Hispanic, mainly of Mexican descent) were equally represented in the research sample, and that students who reported both high and low activity levels were also represented. I chose to divide the sample in this way because I hypothesized that ethnicity might affect total sleep time on weeknights or weekend nights, and that activity level might directly affect both sleep quantity and

caloric intake. Also, when testing hypotheses about the relationship between total sleep time and caloric intake or dietary composition, a sample of 40 permitted up to 300 “food-days.” In other words, since each study participant would be completing food and sleep diaries over one, two or three *three-day* periods across the year, 40 participants would provide at least 120 days of food and sleep data (40×3) on each data-collection occasion, and if, as I hoped, all participants completed six during-the school year days of food and sleep diaries ($40 \times 6 = 240$), and if half of the sample completed diaries over the summer ($20 \times 3 = 60$), the result would be 300 “food-days.”

When I began spending time in the freshman science classrooms, I discovered that many teens were quite interested in their own sleep, and therefore in my study. By the time I was ready to make an official recruitment effort, I anticipated that I would not have any problem recruiting 40 participants. Most teens knew they did not get enough sleep, and felt the consequences of this on a daily or almost-daily basis during the school year. My official recruitment consisted of a brief presentation to each science class about my study and what participation would entail, followed by the distribution of a brief screener questionnaire to all students present in the class. The teens who did not want to participate circled their ethnicity and activity level, as well as “no, I would not like to participate” on the screener, and those that did want to take part in the study circled ethnicity, activity level, “yes, I would like to participate” and provided me with contact information. In this way, everyone spent a few minutes filling out a form, and I could follow up with interested teens later. “Following up” included confirming with a student

that they wanted to participate, and giving them a consent form that had to be signed by them and also by a parent or guardian, since they were all under 18. Although I did not want to expand my sample too much, I ended up including 11 additional participants because they had an interest in the study, and they returned signed forms to me. Five of these participants were not of White or Hispanic ethnicity, and six were members of groups (for example, White high-activity males, Hispanic low-activity females) that I was trying to recruit, but multiple teens returned forms to me at the same time, so I ended up with up to 8 teens in some categories, and only 4 in others (for example, Hispanic high-activity males).

A few teens I talked to at the school most likely had serious sleep problems, such as chronic insomnia. None had been formally diagnosed, but all were seeking ways to sleep better. These teens often wanted to speak with me, but they did not want to be part of my study, because it would entail extra work on top of the required work they were already finding it hard to complete because of their debilitating tiredness.

My final sample consisted of 51 adolescents, whose demographic information is detailed in **Table 3**, below.

Table 3: Demographic characteristics of the sample

Demographic Variable			Demographic Variable		
Ethnicity	Number	Percentage	Mean Body Mass Index (BMI)		
White	23	45%	Overall	23.71	
Hispanic	23	45%	Male	24.52	
Other*	5	10%	Female	22.96	
Gender			White	22.80	
Male	24	47%	Hispanic	24.00	
Female	27	53%	Other ethnicity	26.61	
<i>Original</i> self-report activity level			Revised activity levels		
High	24	47%	Weekday High (> 4.67 mean METs per day)	14	33%
Low	27	53%	Weekday Medium (between 3.87 and 4.67 mean METs per day)	15	34%
			Weekday Low (< =3.86 mean METs per day)	14	33%
Mean age	14.5 years		Weekend High (> 4.67 mean METs per day)	14	32%
			Weekend Medium (between 3.51 and 4.67 mean METs per day)	15	34%
			Weekend Low (<= 3.50 mean METs per day)	15	34%

* 3 African-American, 1 Native American and 1 Native American/White

The fact that activity status (habitual activity level) was determined by self-report began to create problems when I began data analysis. On the screener, teens were asked to circle “I participate in sports or athletic activities...often (daily or almost daily team practice or individual workout) sometimes (2-3 times a week) or rarely (1 or 0 times most weeks).” Self-reporting activity level probably resulted in some students who participated in a lot

of activity that might not have been seen by them as “formal physical activity” being classified as low-activity. For example, Honor, a 14-year-old Hispanic female, reported dancing recreationally quite a bit, including being involved in three quinceañera parties (see Ch 4) which had weekend dance rehearsals. Yet she is classified as low activity. Some teens who circled “low activity” also spent a lot of time walking – from their houses to the bus, from the downtown transit center to the school, all over various parts of the city after school. Although this was not high-intensity activity, many teens walked frequently because the bus did not take them everywhere, and parents were not always available to pick them up, and this type of activity was not taken into account by me or by the teens when they estimated their overall activity level. Also complicating data analysis was the low frequency of teens marking “sometimes;” because this was rarely circled, I combined “sometimes” and “rarely” responses into a “low-activity” category.

In response to this mismatch between self-report activity level and actual activity of teens in this population, I calculated two revised versions of the habitual activity variable, based on actual activity reported by teens on 1) weekdays and 2) weekends. I converted the actual activities reported by teens into a mean metabolic equivalent of task (MET) score using Food Processor version 10.0 and SPSS 15.0. METs express the energy cost of physical activities as a multiple of an individual’s resting metabolic rate (RMR). Though individuals each have a slightly different RMR, METs provide an estimate of the intensity of an activity. Using mean weekday and weekend values for this variable for each teen, I re-assigned them into high, medium and low activity categories based on

their actual activity. This classification gave a better picture of physical activity among these participants, and the breakdown of teens in each of these revised categories is also presented in **Table 3**, above.

Incentives

Non-monetary incentives (gift cards) were given to adolescent participants who took part in the study from its inception (October 2006) to the end of the 2006-2007 school year in May 2007 (\$10 for Starbucks) and summer and fall semester 2007 project activities (\$20 for the movies) to encourage them to complete paperwork. All students who enrolled in the study and subsequently talked with me or completed any diaries were given the \$10 gift card. Typically, they completed a 10-day sleep diary, participated in a one-on-one interview with me, and completed 3 days of diary data collection before the Starbucks incentive. Students who received the \$20 gift card had typically completed one or two additional 3-day diary data collections (depending upon whether or not they participated in the study through the summer) along with short questionnaires about sleep, activities and technology use. I made an effort to contact all student participants in the fall of 2007, even if they had changed schools, to see if they wanted to continue participating in the study. If I was able to contact a student, even if they did not complete additional data collection after Spring 2007, they received a movie gift card from me.

Research Methods

This study draws on both biocultural theory, detailed in the Introduction and Chapter 2, and biocultural methods. Conducting biocultural research on sleep means exploring biological, cultural and environmental factors, how they interrelate, and how, together, they affect adolescent sleep behavior and also the coping behaviors teens engage in when they get inadequate sleep, as illustrated in the biocultural model presented as **Figure 1** in the Introduction. In order to capture the breadth of teen attitudes and behaviors around sleep, and also external factors affecting sleep, I relied on multiple methods, summarized in **Table 4** below. Although interviews and participant observation were my primary methods for capturing teen perceptions of sleep, I also returned to information gleaned from these methods as I addressed all of my other questions, seeking to integrate the cultural knowledge and behaviors expressed and performed by my teen participants into all aspects of this study.

Table 4: Research methods used to address major questions

Major Research Question	Main Methods Used
<i>How do adolescents in this population perceive their own sleep? This includes an examination of factors that they think affect their sleep, their perceptions of sleep need and ideas about sleeping too much and too little, and their sources of information about sleep.</i>	<ul style="list-style-type: none"> • Interviews • Participant observation
<i>What constitutes "normal sleep" in this population of adolescents?</i>	<ul style="list-style-type: none"> • Sleep diaries • Interviews • Participant observation
<i>What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?"</i>	<ul style="list-style-type: none"> • Sleep diaries • Food diaries • Activity diaries • Interviews • Participant observation
<i>How does late-evening technology use interact with teen sleep in this population of adolescents?</i>	<ul style="list-style-type: none"> • Sleep diaries • Technology diaries • Brief technology questionnaire • Interviews • Participant observation
<i>What are specific ways in which adolescents cope with inadequate sleep? Do strategies vary with regard to household composition, gender, or ethnicity?</i>	<ul style="list-style-type: none"> • Sleep diaries • Food diaries • Questionnaires • Interviews • Participant observation • Activity diaries (exploratory)

Learning about teen perceptions of sleep

Interviews

The main way that I elicited teen perceptions of their own sleep was by conducting semi-structured interviews (N=51). Taylor (2005) suggests that interviews are an appropriate methodology for accessing study participants' understanding of the world, and also their experiences. The interview involved students individually being pulled out of science

class during a 90-minute class period, and engaging in a face-to-face interview. They also completed two sets of questionnaires, one at the beginning and one at the end of the interview. The interview (24 questions), ran 30 to 60 minutes, while questionnaire completion took between 15 and 25 minutes. The interview included questions on the adolescent's own sleep patterns and perceptions of sleep, ideas about sleeping too much and sleeping too little, sources of information about sleep, sleep and food intake, and girls vs. boys sleep. The questionnaires included a measure of overall sleepiness, an activity diary for the day prior to the interview, and a researcher-developed instrument probing technology access and estimated use on weekdays and weekends, and four aspects of mental health. Most interviews were conducted in an empty science lab, but when this room was unavailable, a variety of other interview locations, including the school library, outside at a lunch table, and even a stairwell, were used. In addition to the interview, some parts of the Time Three (Fall) questionnaire asked participants open-ended questions about how much sleep they thought they needed on weeknights and weekends, and whether they thought they could catch up on lost sleep, and how.

Overall, teens were very interested in sleep as a topic. They were able to easily answer many of my questions, although some teens told me they had no idea about some of the relationships I was interested in, such as how sleep and food intake might interrelate. Some teens also answered that they didn't know about gender differences in sleep, typically because this was not something that was talked about among teens, and their own experience included perhaps just a father or mother as an exemplar of how the

opposite sex slept. Due to the nature of science class scheduling, the three teachers I worked with taught their freshman classes 1st – 4th period, so I did a disproportionate number of interviews during the first period of the school day. This probably caused some participants to be less talkative or engaged than they might have been had I conducted interviews later in the day. Some teens did have questions for me. The one I heard most often was, “So how much *should* I be sleeping?” They also often asked me about why I was studying teen sleep, and my graduate school trajectory more generally.

Participant Observation

Participant observation consisted of observing and hanging out, typically before school, during science classes and homeroom, at lunch, and occasionally after school. It was typically conducted for one to three hours at a time, though it was often broken up – for example, 30 minutes before school, 10 minutes in the beginning of class before taking a student out for an interview, and 5 minutes at the end of a class. Participant observation began as a way to get to know teachers and students in September 2006 and continued on an intermittent basis through April 2007, with a few additional notes made in October and November 2007 as I administered Time Three (Fall) questionnaires and diaries. While at the school, I generally made notes on the alertness level of teens in class and what affected their alertness, any comments I overheard or conversations I participated in about sleep or sleepiness, what teens were eating and drinking, and technology use in and out of class. These observations helped me contextualize the data I collected from teens about their sleep, food intake and technology use.

Over the summer, participant observation moved online. During the summer of 2007, the social-networking site “MySpace” was a very popular online destination for teenagers. Launched in January 2004, MySpace allows users to create online profiles that are then connected by links to their friends on the system. Profiles reflect personal interests and tastes and often include text about the individual as well as pictures, videos and music. . In July 2006 MySpace was ranked as the #1 U.S. website by traffic in a one-week period, even surpassing Google (Gefter, 2006). When The Pew Internet in American Life project conducted a telephone survey of 935 teens in October and November 2006, (incidentally, coinciding with the start of my dissertation project) they found that 55% of the “online teens” (886 of the 935 interviewed) had created a profile page and that 85% of these teens reported using or updating their MySpace profile most often (Lenhart and Madden, 2007).

MySpace, like other social networking sites, requires that you register on the site, and then request that other users become your friends. I had asked teens during the interview if I could contact them on MySpace, and most said “sure.” So I searched for them and sent them friend requests, to which most responded affirmatively. Finding teens online was easy. Most of my participants had internet connections at home, and they chose to be on MySpace to be with friends, even if they were stuck at their own houses. MySpace gave me insight on teen behavior when it was mostly just teens – while they might have the occasional older friend online, chances are excellent that most of their parents weren’t monitoring what was said on MySpace.

This online social-networking participant observation presented some ethical issues not raised by participant observation conducted where participants are aware of the researcher's presence. Therefore, I used only relatively public items circulating on MySpace, and I avoided items that might identify a particular participant. For example, I noted decorative schemes and changes made to the profiles of my participants/friends, and printed out bulletins posted by teen friends that reflected the type of communications engaged in on MySpace, especially if the bulletins were directly relevant to my research questions (i.e., questionnaires that included questions pertaining to sleep or sleepiness).

Capturing adolescent sleep behaviors

In order to collect data on actual sleep patterns, I used prospective sleep diaries. In a sleep diary, participants are instructed to answer a set of standard questions about the prior night's sleep, ideally immediately upon awakening in the morning. Participants completed these diaries on between 3 and 9 nights specified by me between February 2007 and November 2007. The sleep diary contained eleven questions covering both sleep and caffeine intake for the previous night/day. See **Table 5** below. Sleep diaries are an often-used method in sleep research to capture data on the sleep of individuals with a suspected sleep disorder, as well as the sleep of "normal sleepers" (Morin et al., 1999). Limitations of the sleep diary method include errors associated with self-report data (Ancoli-Israel et al., 2003), but its strength is that it is a simple method that requires only a small time investment from participants on waking.

Table 5: Sample sleep diary

	TUESDAY NIGHT SLEEP		TUESDAY NIGHT SLEEP		TUESDAY NIGHT SLEEP
1. Yesterday, I napped from ___ to ___ (Note times of all naps)	5 pm 5:30 pm	5. After turning off the lights, I fell asleep in ___ minutes	5	9. This morning I got out of bed at ___ o'clock (specific time)	5:45 am
2. Yesterday I drank ___ caffeinated drinks before lunch, ___ caffeinated drinks between lunch and the end of school (or 3 pm if a weekend) and ___ caffeinated drinks between the end of school/3 pm and bedtime	1 0 3	6. My sleep was interrupted ___ times during the night (how many times did you wake up?)	0	10. Overall my sleep last night was (Choose One) 1 = very restless 2 = restless 3 = average quality 4 = sound 5 = very sound	3
3. Yesterday, I took sleep medication to help me go to sleep (Yes/No) If Yes, which one?	No	7. My sleep was interrupted for ___ minutes during each awakening	0	11. Overall my sleep last night was (Choose One) 1 = worse than usual 2 = same as usual 3 = better than usual	2
4. Last night, I went to bed at ___ o'clock and turned off the lights at ___ o'clock	10:00 pm 10:27 pm	8. This morning I woke up at ___ o'clock (last awakening)	5:35 am		

Participants kept sleep diaries for a set number of days at four times across the school year and summer. When participants entered the study, they were asked to complete a 10-day sleep diary that would span normal week and weekend days (N=48). Once all participants had completed this diary, adolescents kept three days of sleep diaries on weeknights during the Spring semester of the 2006-2007 school year (Time One, N=50), and three days that spanned a weekend during Fall semester of the 2007-2008 school year (Time Three N=44). Overall, I had a study drop-out rate of 12% across the study, which seems reasonable given that the majority of students (4 of 6) who stopped participating after providing weekday data changed schools for the 2007-2008 school year. Only 2 students still attending the study school in 2007-2008 stopped participating, both for reasons involving illness. A subgroup of participants also kept three days of sleep diaries over three summer days (Time Two N=20). Times One, Two and Three were approximately synchronized. Due to block scheduling in the high school, it was impossible to get all students to keep sleep diaries on exactly the same days, but I sought to have them complete the diaries as close together as possible to minimize potential sleep variations caused by seasonality (Benefice et al., 2004), exam schedules, etcetera.

In addition to my primary reliance on sleep diaries to help me describe teen sleep behavior, I also asked teens about their typical weekday, weekend and summer sleep during the interview. These descriptions, adolescent comments about things that affected their sleep, and their physical feelings associated with inadequate and adequate sleep helped me understand how teens embody “healthy” sleep and “teenager-appropriate” sleep, and how they physically experience sleep loss and “too much sleep.” Participant

observation, including overheard comments about sleep and lack thereof from teens and teachers alike, also helped me contextualize the culture of inadequate sleep reproduced in high school.

Exploring food intake, caffeine intake and activity in relation to sleep

In addition to the sleep diaries described above, prospective food diaries and activity diaries, described below, allowed me to address the research question “What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?”

Adolescent participants completed prospective food diaries of my own design over the same three-day periods that they kept sleep diaries. The three-day period was selected to maximize the accuracy and reliability of the food diaries (Schlundt, 1988; Tremblay et al., 1983), while not placing an undue burden on teens. The food diaries prompted participants to record each eating event by listing meal and snack opportunities (breakfast, morning snack, etc.) with plenty of lines beneath, and providing a sample breakfast recorded at the hoped-for level of detail. See **Table 6** below.

Table 6: Blank food diaryFOOD INTAKE RECORD - **THURSDAY**

Directions: Please write down everything you eat, and be as specific as possible about what it is – see breakfast example.

Meal/Snack	Food Description	Quantity (teaspoon, tablespoon, cup, piece, packet, etc.)
BREAKFAST	<i>Example:</i> Bagel, cinnamon raisin, 3 ½ in., toasted	1 bagel
	<i>Example:</i> Cream Cheese, regular, plain	2 tablespoons
	<i>Example:</i> tea, black, English breakfast, brewed	2 cups
	<i>Example:</i> sugar	2 teaspoons
	<i>Example:</i> half and half	2 ounces
MORNING SNACK		

Concurrently with the food diaries, participants completed the researcher-designed “Coke, Candy and Cellphone” (CCC) diary intended to capture all caffeinated beverages, “sugary snacks” (as defined by the participant) and also all technology use (discussed below). See **Table 7: Blank coke, candy and cellphone diary**. The CCC diary proved useful because in some cases, teens would fail to write their beverages on the food diary but would record them all (caffeinated or not) on the CCC diary. Although many times

the “sugary snacks” were represented on the regular diary, sometimes they only appeared on the CCC diary.

Table 7: Blank coke, candy and cellphone diary

TUESDAY

I drank the following beverages with caffeine

Beverage	Size (8 oz, 16 oz, 20 oz, 32 oz, other (please specify))	Time consumed
Example: Coca-cola	20 oz	8:15 AM
Example: Iced tea	32 oz	6:30 PM

I ate the following foods with high sugar content (“sugary junk foods”)

[Do not worry about overlapping with your food intake diary – enter these sugary foods both there AND here]

Food	Size	Time consumed
Example: Snickers Bar	1 standard-size bar	3:30 pm

I communicated with others using technology

Technology	Time Started to Use	Time Stopped Using
Example: called parents on cell phone	11:12 AM	11:15 AM
Example: emailed friends	3:30 PM	3:45 PM

During the days that participants collected food information, they also filled out an activity diary. The diary took the form of a fairly comprehensive list of activities, and

teens checked which ones they did and wrote down how many minutes or hours they estimated they had engaged in that activity. The list of activities used was based on a list of activities from the Amherst Health and Activity Study Student Survey developed by Dr. James Sallis (Sallis, n.d.), available online at a web address listed in **Appendix A**.

See **Table 8** below for a blank activity diary.

Table 8: Blank activity diary

Thinking about TODAY...did you do any of the following activities?

Check **WHAT** you did and **WHEN** you did it, and estimate the total number of minutes of that activity.

Activity	Before School	During School	After School	Minutes of Activity
Aerobics/Aerobic Dancing				
Ball Play: kickball, catch				
Baseball or Softball				
Basketball				
Bicycling				
Cheerleading, Marching Band, Drill Team				
Climbing Stairs for Exercise (or Stairmaster)				
Dance Classes (ballet, jazz, modern, tap)				
Dancing (social, recreational)				
Exercise: push-ups, sit-ups, jumping jacks				
Football				
Field Hockey				
Frisbee Games				
Golfing				

Activity	Before School	During School	After School	Minutes of Activity
Gymnastics				
Ice Hockey				
Indoor Chores: mopping, vacuuming, sweeping				
Laser Tag				
Martial Arts (karate, judo)				
Outdoor Chores: mowing, raking, gardening				
Racquet Sports: tennis, racquetball, badminton				
Rowing machine				
Running (outside or treadmill)				
Skating (ice, roller, in-line)				
Soccer				
Swimming Laps				
Volleyball				
Walking for exercise (outside or treadmill)				
Walking for transportation				
Water Play: pool or lake				
Weight lifting				
Wrestling				
Other:				

I conducted follow-up interviews with teens as they handed in their packet of sleep, food and activity diaries. These brief interviews were informal, but all included questions that

probed portion sizes and especially areas of the page left blank, asking participants why they ate no lunch, or ate only junk food on particular days. I was also able to ask about food items that were unfamiliar to me (which occurred in some cases with Mexican foods prepared at home). I also employed a collection of plastic food models selected from a larger set to reflect the items most often consumed by the teen participants. These models, which are labeled with their exact size (3 oz of chicken, $\frac{1}{4}$ cup of peas, etc) were extremely helpful in estimating portion sizes with participants. See **Figure 2** below.



Figure 2: Plastic food models of grilled chicken, mashed potatoes, peas and grape juice

I also asked teens about activity diaries in the follow-up interviews, prompting adolescents to estimate time spent in walking for transportation, or going up and down stairs on the high school campus. Probing the contents of the activity diary also revealed daily activities not necessarily highlighted in the activity diary, but that happened to be physical (such as five hours of skateboarding, or an hour of playing the very active video

game “Dance Dance Revolution). This follow-up interview also enabled me to confirm that no recorded activities really meant *no* physical activity, and to check on durations of activity that seemed unusually long or short. Over the summer I conducted such follow-ups via email.

Once I had conducted a follow-up interview with a participant, I entered each food-day into the record I had created for each participant in ESHA Food Processor SQL, version 10.0 (copyright 2006-2007). Within the food program, I selected the closest food item in terms of content and size to what the teen listed on their diary. Most items, or similar equivalents, were represented in the ESHA database. Some items, however, such as energy drinks, specialty drinks from Starbucks, and some Mexican foods, were not in the database and so I entered nutrition information obtained from the World Wide Web into the ESHA database. I also entered physical activity data into each participant’s Food Processor record.

Participant observation within the high school included observations at lunch, between classes, and occasionally after school. I also observed students snacking in class, especially at the beginning of third period and sometimes during homeroom. Teens were also asked in the interview if they thought sleeping too little one night affected the quantity or type of food they ate the next day.

Technology use and sleep

In order to address the question, “How does late-evening technology use interact with teen sleep in this population of adolescents?” I primarily utilized sleep diary information, as well as the technology diary component of the Coke, Candy and Cellphone diary, shown above in **Table 7**. This diary is, to my knowledge, the first of its kind, modeled after a prospective food diary. It enabled teens to keep a record of their technology use, although these records varied in quality by participant. Some adolescents reported to me that they knew their “tech diary” was incomplete, while others seemed to be fairly exhaustive in reporting time spent on MySpace, on the cell phone, etc. In addition to this diary, at the end of data collection for Time 3 (Fall 2007) diaries, participants completed a brief questionnaire either in person or over email which asked about technology in their bedroom, which technology items they had access to after 10 pm, and which ones they sometimes or often used after 10 pm. Finally, though there were few questions specifically related to technology use in my interview guide, many comments made by participants over the course of the interview, and also around school, pertained to technology use. I also observed in-school youth technology use. While this could not tell me exactly how teens used technology in the late evening, it gave me a sense that these teens who were communicating via cell phone and listening to Ipods at almost every chance they got (in an environment that placed strict restriction on the use of these devices) would likely be voracious consumers of a variety of media if given the opportunity at home.

Examining coping behaviors in response to inadequate sleep

To answer the questions, **“What are specific ways in which adolescents cope with inadequate sleep? And do strategies vary with regard to household composition, gender, or ethnicity?”** I drew on data collected through a variety of methods. I hypothesized, based on current literature, that coping with inadequate sleep might be reflected in 1) napping or 2) adjusting sleep timing the next night (Yang et al., 2003). Information to assess these hypotheses was primarily contained in the sleep diaries described above. Additional hypotheses suggested by literature included 3) altering food intake (including total caloric intake and “junk food” intake)(Van Cauter and Knutson, 2008) 4) increasing caffeine intake (Landolt et al., 2004; McLellan et al., 2005) or 5) decreasing physical activity (Gupta et al., 2002) in response to inadequate sleep. These hypotheses were examined using data from prospective food diaries, the Coke and Candy portions of the CCC diary, and the activity diaries also described above.

In addition to sleep, food and activity diaries, questionnaires, interviews, and participant observation aided in the examination of adolescent coping behaviors. One of my questionnaire questions was, “Do you think you can catch up on lost sleep? If so, how?” This question produced interesting results with regard to teen perceptions of how they might be able to cope. Although the interview did not specifically address coping behaviors, teens made comments during the interview about coping with sleep loss. I also asked teens about their families, including whether they lived with two parents, one parent, or in another situation, that enabled me to explore whether coping behaviors were

related to household composition. Participant observation also revealed some teens engaging in potential coping behaviors, such as napping in class or snacking on junk food or caffeinated drinks.

Having now addressed the main data-collection methods for this research, the next chapter will introduce the high-school field site and explore how adolescents both learn to embody and practice embodying “teen sleep” within the dual social contexts of a large high school and their homes and families.

CHAPTER 4: SOCIAL INFLUENCES ON TEEN SLEEP, FROM ACTIVITIES TO THE SLEEP INDUSTRIAL COMPLEX

This chapter answers the question, “**How do adolescents in this population perceive their own sleep?**” By first introducing the high school field site, I describe one of the main cultural environments that shapes teen ideas about sleep. I explore the interacting influence of high school and the other main sleep-influencing cultural environment, the home, by asking teens about factors that they think affect their sleep, and their sources of information about sleep, including friends, parents, and the media. The advice, direct and indirect, given to these teens about sleep influences their normative embodiment of sleep, or how they conceptualize sleeping in a healthy way. Sleep advice also influences their pragmatic embodiment of sleep, giving them ideas about how to sleep in a way that is appropriate for their social role. To conclude, I examine adolescent perceptions of sleep need and teen ideas about sleeping too much. The experience of sleeping too little is addressed as part of Chapter Six on what constitutes normal sleep in this population, as for most teens on most days, “normal sleep” means sleeping too little.

Sleep perception hypotheses?

As discussed in Chapter 2, very few studies have looked at sleep perceptions in the way that this study approaches them. Noland and colleagues (2009) gave high school students a 37-item questionnaire designed to gauge their sleep patterns as well as their perceptions of operating on too little sleep, things that helped them get to sleep, and that kept them

from getting enough sleep. When teens in their study were operating on too little sleep, these adolescents reported feeling more tired during the day, having difficulty paying attention, receiving lower grades, feeling more stressed, and having difficulty getting along with others (Noland et al., 2009).

In a group of 64 middle school students attending a sports summer camp for inner-city children, Owens and colleagues' (2006) interview findings illuminated reasons for inadequate sleep in this population, consequences of inadequate sleep, and sources of sleep information. These researchers concluded that though participants placed a relatively high value on sleep, television and other media often prevented them from getting adequate sleep. Although these pre-teens did not want to curtail media use on their own, when asked about how to obtain improved sleep, they suggested that their parents place limits on media use. Consequences of inadequate sleep included tiredness, irritability, mood changes, low motivation, cognitive and attention problems, and a perceived negative effect on physical appearance. However, for some participants, there were no discernable consequences to sleeping too little. Sources of sleep information included teachers, parents, doctors and coaches, with doctors seen as perhaps the most credible, and least disciplinary messengers (i.e., they did not give punitive consequences if students failed to sleep).

These studies are useful because they begin to address the complex world of teen sleep beyond basic reports of sleep timing and connections to commonly-investigated variables

such as depression, self-esteem and school performance. While it is important to document relationships between these variables and sleep patterns, it is difficult to propose an intervention to improve teen sleep without understanding how teens think about their own sleep. Following Owens and colleagues (2006), I expect that technology use will play a role in teens getting too little sleep, and that teachers, parents and coaches may provide sleep information to teens. However, these findings on sleep perceptions in teenagers will be largely descriptive, rather than testing specific hypotheses about adolescent perceptions of sleep.

The field site: high school

Seven thirty AM. I drive up to the guard booth for the visitor's parking lot (See Color Plates, **Figure 4**, starting on p.107). The guard on duty asks for my ID and who I am going to see. I give him my driver's license and tell him I am seeing Mr. F. He writes down some information and gives me back my license, encased in a plastic visitor's badge that I am to hang around my neck the entire time I am in the school so security can recognize me. As the security personnel get to know me through my subsequent frequent visits, they write down less and wave me through more. Even though I am often here 3 days a week I still wear the visitor badge – to get a more permanent ID I have to be a school district employee.

The high school is a large one, accommodating approximately 3000 students here on a busy downtown corner of the city. It is a magnet school, so although some students are

bussed in on traditional school busses, many more take the city bus or get a ride from their parents every morning. Walking in from the visitor parking lot, the football stadium is to my right, and the school spreads out to my left. In typical Southwestern fashion, the school includes a large outdoor gathering area, which everyone calls “the mall,” and it provides a place for students to hang out when they are not in class. It is mainly concrete, with a bit of grass on the end near the stadium. Trees are planted in tree-wells throughout, often shading metal outdoor tables coated in plastic, because if they were simply metal they would be un-usable during 100+ degree afternoons (See **Figure 5**)

There are four main buildings, named for the main classes they house: Humanities, Science, Vocations and the Gym. The student cafeteria looms to one side of the mall, cleaving to the Humanities building, and there is also a teacher cafeteria, accessed through two unobtrusive doors on the back of the student cafeteria, facing the Science building. In addition to the shade trees, there are several large metal structures (ramadas) to shade a set of vending machines and more lunch tables. Beyond the mall and the main school buildings, basketball and tennis courts (see **Figure 6**) stretch back to a couple of parking lots, one for teachers and another one that provides a small amount of student parking, as well as overflow parking for visitors. See campus map, below.

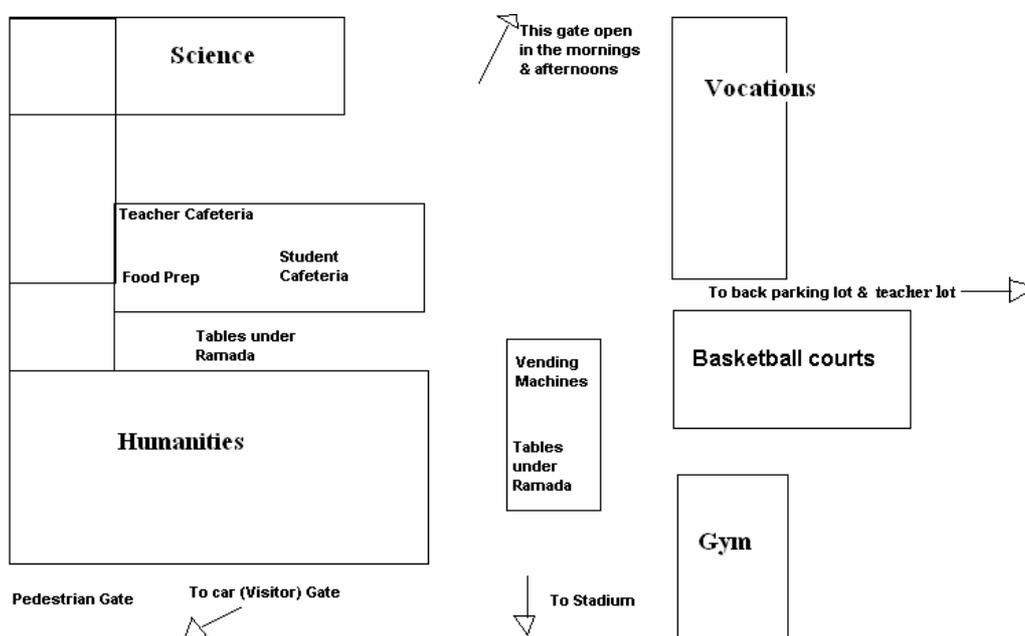


Figure 3: High school map

During the 2006-2007 school year, there were 848 9th graders enrolled at the high school. Of the total student body, almost 59% were Latino/Hispanic, mainly of Mexican descent, while just over 29% were white, 6% were black, 2% were Asian and 3.5% were Native American. I chose this high school because it was a magnet school and therefore is required to have a demographic makeup that matches that of the surrounding city. Given this, I anticipated that this magnet school would be a good place to recruit both White and Hispanic teens, and also to get a cross-section of both socioeconomic status and student achievement among Southwestern teens.

A day in the high school: routines and ritual

A typical school-day routine from the time of arrival at school went something like this: Between 7:00 am and 7:45 am, the teen arrives at school, either by school bus or city bus, or they are dropped off by a parent. They head to a pre-determined spot (the library, the band room, or some designated area outside), most often to meet friends and chat with them before school starts. Sometimes they attend “conference period,” a twenty to fifty-minute (depending upon the day) pre-first-period time when students could go to their classroom teachers and ask questions, make up a quiz, etc. Especially as the weather gets colder in the winter, students hang out more in the library or in the conference period of their favorite teachers (even if they do not have questions) before school. For several months during the year I spent in the high school, the Future Business Leaders of American chapter at the school ran a coffee shop in the Science building before school, so teens sometimes stopped there for a quick caffeine boost or breakfast bagel (see **Figure 7**). The first bell typically rings at 7:53 am, alerting students that they have seven minutes to get to their first class. The school operates on a block schedule, so on Mondays and Wednesdays, teens attend 2nd, 4th and 6th periods for approximately 90 minutes each, and attend a homeroom period for 30 minutes, and on Tuesdays and Thursdays they attend 1st, 3rd, 5th, and 7th periods, with a much shorter homeroom. On Friday, teens attend all of their classes for 50 minutes. Because of the block scheduling mentioned above, 1st and 2nd periods both function as the first period of the day. Because the teachers with whom I work teach their science classes 1st – 4th period, I end up recruiting a lot of students in their 1st and 2nd periods. Thus, I conduct many interviews during the first period of the day, experiencing student fatigue first-hand.

Because they are used to the longer periods, several students comment to me that Fridays exhaust them because they are constantly running between classes. Start times vary across the week, with Monday's start being the latest (8:30 am in 2006-2007, 9:00 am in 2007-2008). Because parental schedules do not change across the week, however, most teens get to school between 7:00 and 7:45 am daily. At the first bell, students start moving toward their first class. Many may still be listening to their MP3 players or sending a quick text message on their phones, even as they chat with friends and negotiate the stairs to their classroom. Security is tight at the school. All students, teachers and visitors wear ID badges that must be visible to the security personnel who move through the school on a regular basis. Even while teens are in class, security guards bike through the campus to be on the look out for any unauthorized visitors (see **Figure 8**).

When the first period finishes, students enjoy a brief break between classes, again pulling out MP3 players or cell phones to check in, and talking with friends on the way to their next class, or on some days, first lunch (which begins as early as 10:07 am on Wednesdays). If it is a Tuesday or Thursday, one-quarter to one-third of a given science class may be snacking at the beginning of third period. The snacks range from healthy (fruit, goldfish crackers) to not-so-healthy (varying types of chips, fruit snacks, candy). A routine similar to that seen in the first period plays out, with the inclusion of a homeroom period at the end of the second period. Some days this homeroom is long, and

teachers try to use the time, either by encouraging students to read as part of a school-wide “Tiger Read,” named for the school’s mascot or, in a few cases, trying to educate students about the country for which the classroom is named. All classrooms are assigned a country designation, and in one particular classroom, Tibet, students watched a video over several homeroom periods about the country. In Madagascar, they had a much briefer “country education,” consisting of being grossed out by some live Madagascar hissing cockroaches. Mainly homeroom turns into a bit of a free-for-all, with students finishing work from the class period, talking to friends, or listening to their MP3 players if the teacher permits it. Few students, even those who seemed quite tired during the class period, used the homeroom time for sleeping, since this would likely cut into time spent socializing with friends (see **Figures 9 and 10**).

Lunch continues in the same vein, only with less supervision. For many teens, lunch does not seem to be very much about eating. They may eat incidentally (consume a bag of chips or a bottle of iced tea, or snag a few fries or other food from a friend) but lunch serves mainly as a hang-out time with friends. As classes are let out, teens make a bee-line either to the cafeteria line to quickly purchase food (see **Figure 11**), or to a pre-arranged location to meet their friends. Cafeteria food does not seem to have changed much over the years, even with a more widespread focus on healthy eating. In Arizona, a “junk-food” ban went into effect in 2006 for elementary and middle schools, focused especially on making snack bar and vending machine items more healthy, but this does not apply to high schools. For lunch, students typically choose a hamburger,

cheeseburger or piece of pizza, most often accompanied by French fries and chocolate milk or water. Salads are available, but my study participants characterized them as not very appetizing. The student store sells bagels with cream cheese, various types of chips and drinks as well as frozen “slushee” drinks, while vending machines provide Vitamin Water and “healthy” chips (i.e., Baked Lays, Baked Cheetos - See **Figure 12**).

With such a large school, lunch operates in two shifts and a student’s lunch assignment may change from day to day according to where their third and fourth period classes meet. So they may have two groups of “lunch friends” that they eat with, alternating depending upon which lunch they have on a given day. Students spend lunch, after the initial flurry of buying things from the cafeteria, student store, or vending machines, sitting with friends or walking around. Lunch is a time where students are permitted to use MP3 players and phones, and many take advantage of this, particularly in “transition times” between when class gets out and when they meet up with friends, for example. General “technology” rules at the school prohibit teens from using phones or other electronic devices (MP3 players, portable game systems) during school hours, with lunch as the exception (See **Figure 13**). In theory, this means no phones or Ipods in class or even between classes. One teacher tells me that administrators want teachers to patrol the halls and take phones away from students, but he says he doesn’t want to do it. He is willing to take phones away in his classroom (See **Figure 14**), but the idea of taking phones from students who are complete strangers does not sit well with him.

Lunch may also be a time to do a little homework that is due by the end of the day, or to play some basketball, or to campaign for student government positions at certain times of the year. Like homeroom, lunch is not typically a time for sleeping because there are too many friends and acquaintances around. Finally, the last period of the day arrives. After lunch, students tend to be more lethargic, but the last period of the day, depending upon its content, may bring renewed energy as teens look forward to their afternoon. When the final bell rings, students pour outside from the classroom buildings into the large outdoor space ringed by a 7-foot-high fence. Pandemonium ensues as teens find each other, check in, and prepare for their after-school time, moving to a school-sponsored activity (See **Figure 15**), walking off campus with friends to a nearby shopping and food district, or catching a bus home.

Color plates section



Figure 4: Guard booth for the visitor parking lot. Note the fence that surrounds the entire school.



Figure 5: The mall, before the first bell rings



Figure 6: A pickup soccer game, on the basketball courts before school



Figure 7: Coffee shop run by the Future Business Leaders of America chapter. Note the Starbucks Frappuccino for \$2



Figure 8: Security personnel patrol the school when teens are in class

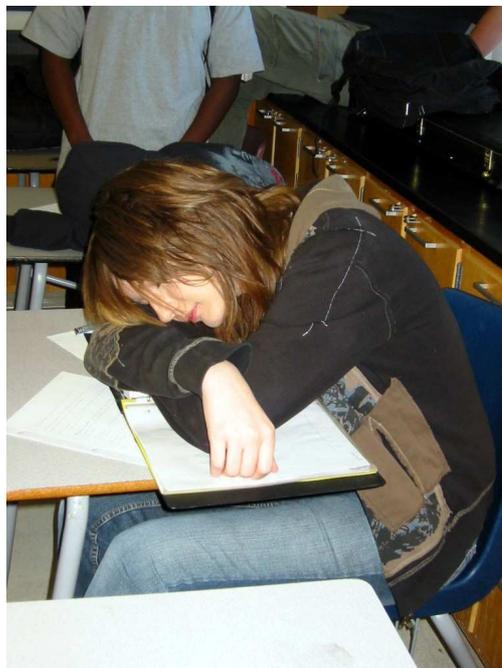


Figure 9: Sleeping student, a posed shot: note the hood that she would have put over her head had she actually been sleeping in class



Figure 10: A science class during homeroom



Figure 11: Waiting in line for pizza



Figure 12: On-campus vending machine advertising chips

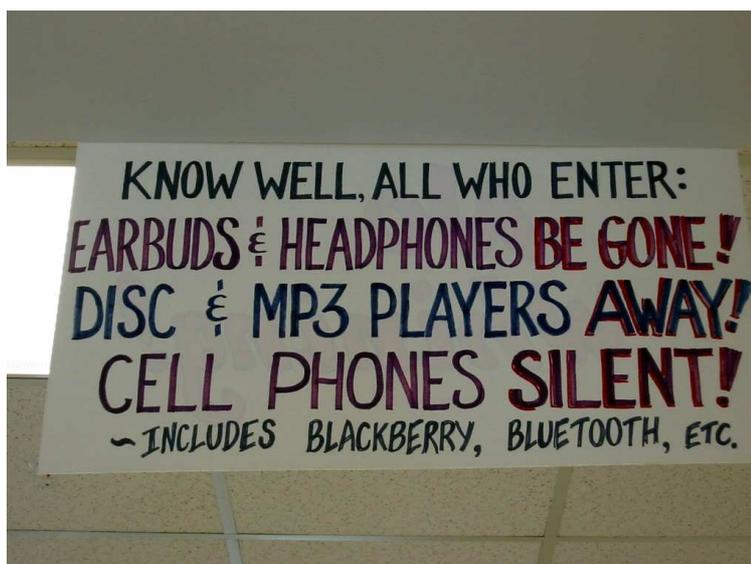


Figure 13: Technology reminder sign in a classroom



Figure 14: Girl texting in class



Figure 15: Marching band practice after school

Cultural influences on teen sleep perceptions

For teens, school and home were two major spheres of influence on their perceptions of sleep. When I asked them where they got their ideas about sleep as part of the interview, however, many looked at me blankly. Although they were able to articulate some ideas about sleep, these blank stares confirmed to me that sleep is part of an individual's habitus. As Jenkins (1992) notes, "for Bordieu, the body is a mnemonic device upon and in which the very basics of culture, the practical taxonomies of the habitus, are imprinted and encoded in a socialising or learning process which commences during early childhood...the habitus is inculcated as much, if not more, by *experience* as by explicit *teaching*" (Jenkins, 1992 p. 75-76, emphasis in original). In other words, sleep is a cultured behavior, and you learn about how to sleep and what value is placed on sleep as part of your daily life, such that you hardly notice you are collecting information about it. When I asked my participants more specific questions about whether parents, teachers, friends or the media shaped their knowledge about sleep, I got more definitive answers. Below, I introduce several key cultural values I discerned by observing in high school and listening to adolescents talk about their school and family lives, and I give examples of what teens said their parents, friends, and teachers conveyed to them about sleep.

The culture of high school and messages about sleep

Over the course of this research I spent time in the classrooms of three different science teachers, two who were teaching the "typical" freshman class, Integrated Science, and

one who taught the “honors” class, Conceptual Physics. In each class, students did a mix of lab and book work, with teachers giving lectures, doing occasional demonstrations, and sometimes showing films to illustrate concepts. Each teacher had his or her own style of classroom management, ranging from the honors teacher who projected a “you are here to learn so you’d better get to work” attitude while still remaining personable and approachable to students, to the Integrated Science teacher who sought to be a “fun teacher” the students could relate to by telling wacky, off-the-wall stories.

No matter the personality of the teacher, school rules still loomed large in the classroom. In fact, in this high school, the dominant values presented by teachers, administrators and security personnel were “obedience to the rules” and “achievement.” Conveying these two values could take up almost all of a teacher’s time in the classroom, and to aid them in this endeavor, teachers preferred that each school day to be as *normal* as possible. By this they meant that the day should follow a predictable routine, so students remained calm and able to concentrate on their school work. Although the usual schedule was one of relatively constant change, students and teachers acclimated to it, and any deviation, such as the insertion of a pep rally on a Friday, or a field trip, altered the normality of the day, and potentially the ability of the teacher to enforce the rules and also encourage achievement.

Regarding specific, enforced rules, some were set by the school, while others varied from teacher to teacher. School-set rules that I often observed being enforced – or at least

discussed - pertained to attendance, proper wearing of one's student ID, the physical location of students at given times, and appropriate use of personal technology. The school was a closed campus, meaning that students could only enter and leave at the beginning and end of the school day. And even within the relative freedom of lunch, administrators could conduct ID checks, making sure all teens were wearing their school ID and displaying it appropriately (i.e., attached to the body above the waist, without any stickers or other items obscuring the ID photo). Students were also not allowed too close to buildings during lunch, even buildings in which classes were not being held. The line which students could not cross was a literal line painted on the concrete, and if students attempt to congregate on the far side of the line, even to enjoy some much-needed shade in the hot Arizona fall or spring, security personnel told them to move. Improper technology use was a frequent target of rules and threats of enforcement, especially in the classroom. It was second nature for some students to send text messages almost constantly, and if a teacher spotted a student texting, or using their phone or another device, school rules suggested that they take away the offending technology. Some teachers actually did this, but others found joking to be more effective. One teacher pretended to be throwing a student's phone in a convenient aquarium, indicating that he was enforcing school rules without the hassle of having to remember to return the student's phone at the end of the period or end of the day.

Within classrooms, I also observed teachers chastising individual students (and often whole classes) to follow teacher-set rules about coming to class on time, being prepared

during class, and signing in and out at the proper spot when they did come in late or have to leave the classroom. About being prepared, I recorded in my field notes:

Several students don't have pencils, and Mr. F talks about being prepared - getting fired their first day of a job for not being prepared - failing to bring materials, showing up late...and how school is a job. Students, especially one female student, dispute this, and another male says "yeah, you can't get fired from school" Mr. F and I say "Yes, you can" Another male student says "You could get suspended."

This teacher also had rules about asking stupid questions. He kept a tally on the board of stupid questions asked by each of his classes, and when a student asked a stupid question (i.e., something that had *just* been answered by the teacher) the entire class lost points.

Linking back to the school technology rules, I observed one conversation between Mr. F and his class indicating that fourth period "had an issue with texting" and that sending texts would now be equivalent to asking a stupid question in Mr.F's classroom-management tally.

Teachers and administrators also devoted a lot of time to the core value of achievement. Academic instruction and teacher time spent aiding students pursued this value, even in the face of some classrooms where few students seemed motivated. All teachers I observed tried valiantly to engage their classes by presenting material in different ways, by using technology to interest teens in a concept, and by planning hands-on science labs and field trips. Sometimes teens were naturally interested in the academic subject matter, and other times teachers succeeded in engaging them. Others, however, viewed most of school, with its focus on rules and achievement, as a distraction from the true value of school to them – a time and place to spend time with friends, and engage in activities they

enjoyed, such as sports or theater or many other extracurricular activities. I could often tell which students were predominantly interested in the social and extra-curricular value of school because during class they would be slumped against their desk, or trying to attract the attention of a friend without alerting the teacher, or texting surreptitiously under the desk. Later in the day, however, I often saw them walking around, hall pass in hand, during class time. “Hi, miss!” they would say, brightly, stopping to get a long drink of water before sauntering into the restroom, or they would wave from a distance as they meandered across the mall, pulling out their cell phone to check the time before reluctantly heading in the direction of a classroom building. All students, however, even those engaged by their school work, felt the pull of social life and after-school activities, and it came out in interviews where students glossed over time spent in class, eager to tell me what they *really* did, besides sit in a classroom, and how the events that happened in their *real* life affected their sleep.

Despite their almost-uniform minimization of “school time” in their discussions of sleep patterns and perceptions, it was clear to me that school *did* affect the sleep of these teenagers. The early school start time (8 am most days) curtailed morning sleep for almost all teens, only a few of whom described themselves as being alert in the morning. Some teens, especially the honors students in my sample, talked about homework as a factor that affected their sleep. But almost none of the teens ever said to me, “I wish school would start later, so I could sleep more.” The only teen who did mention this indirectly was David, a 15-year-old White male who runs cross-country and track, who,

when I asked about what teachers said about sleep, commented, “My Spanish teacher goes on about it. She says school shouldn’t start ‘til 12.”

Although some teachers were sympathetic to tired students, most just encouraged their students to get more sleep, without delving into how this might or might not actually be possible in the lives of individual students. Both teachers and students realized that 8 am might not be the best time to teach a teenager, but it was the time that they were allotted. Although there were no specific school rules about students sleeping in class, it tended to conflict with the value placed on achievement in the classroom setting. Given this, however, teachers reacted in different ways to sleeping students. Some woke the student, or asked a peer to wake them, while others let them sleep unless there was something critical going on (like a test or lab). I got the impression that many teachers believed sleeping students are only hurting themselves, and at least they are quiet. This provided a contrast to the disruptive students (of which there were at least one or two per classroom, sometimes more) who were awake, loud, and disrupting the achievement of others. Other students typically ignored a sleeping student unless they are snoring or otherwise drawing attention to themselves. In that situation, other students sometimes woke the sleeper or did something to attract their attention. For example, from my field notes

Eventually the other students notice that the male is sleeping in the back, and they’re laughing quietly. Only a few students are still working on the test. Finally a girl gets up and tries to put a little piece of paper in the sleeper’s mouth (maybe had flicked it at him before) and he wakes up - he says “I’m just trying to sleep” and someone else says “You were snoring” and he says “Oh, my bad, sorry.”

In addition to shaping teen behavior through rules and a focus on achievement, school also shaped how teens thought about sleep. As a primary location where they interacted with both teachers and friends on a daily basis, school was a place where adolescents learned to embody sleep that fit their definitions of what was “healthy” and “appropriate for a teenager.” Unfortunately, in many cases, these two modes of embodying sleep were in conflict, and “appropriate for a teenager” often won out over “healthy.”

Teachers, who might be more likely to emphasize the health benefits of sleep, were sometimes a source of sleep knowledge. David, introduced above, references specific coursework on sleep, “...and we did reports on deep sleep in my middle school.” A few other teens did report that their middle school science curriculum had included some work on sleep. High school teachers who talked about sleep, however, generally told students that sleep was valuable and that they probably needed more of it, rather than including specific content about sleep in the curriculum. This was not necessarily due to a lack of interest in students’ health and well-being, but because of limited time. Teachers were responsible for meeting state science standards, enforcing school rules and making sure their students achieved at least some measure of success in the classroom, leaving little time for talking about how teens might fit more sleep into their schedules, or make the most of the sleep time they already had. Teacher response to sleeping students also sent contradictory messages, ranging from “let him sleep, he probably needs it” (teaching that sleeping in class might be healthy) to waking sleeping students to tell them that sleeping is inappropriate (teaching that the appearance of achievement may be more

important than achievement itself, given that the student who is tired enough to fall asleep in class probably is not going to be achieving too much even when awake).

While teachers were not speaking directly to healthy sleep, they also were not necessarily helping teens learn to sleep like teenagers. This role seemed to be reserved at school for friends. In interviews that asked about friends as a source of information about sleep, many teens responded that their friends, while occasionally passing on helpful information about sleep, mainly talked about sleep by saying, “I’m so tired,” and by complaining of how little sleep they had obtained the night before. Harry, a 14-year-old White male who participates in marching band, reports that his friends talk about how, “Like they didn’t [get] enough, like, the night before, or ...or else they fall asleep in class.” I heard this rhetoric of “I’m so tired” across genders, ethnicities and activity levels. Some teens used “I’m so tired” to emphasize their commitment to academic achievement. David, a White male in the honors science class, notes, “They say, “I’m tired” or they say “I stayed up ‘til three working on that English paper last night.” Not really anything besides that.” Other teens used “I’m so tired” to show their commitment to non-school pursuits. Roberta, a 15-year-old Hispanic female involved in many activities, including soccer, says of her friends,

Oh yeah, we talk about sleep. Let me see, sometimes it comes up and we’re like, “What time did you go to sleep?” I don’t mean all of my friends, I mean just like, four of them. They are always talking about what time their parents try to make them go to sleep and then they go to sleep and they only get a little sleep...but they’re [all] doing sports... (Roberta, 15)

“I’m so tired” implied to other teens that the speaker “had a life” – important things to do, whether it was participating in activities, excelling at homework, talking on the phone, watching Youtube videos, or a combination of all of the above. It was a way to start or continue a conversation with something everyone had in common, as Mimi Nichter also found in her work with teen girls and their discussions about weight and body image (Nichter, 2000). From this discourse, in combination with messages from parents and media, discussed below, teens learned that sleeping in a “healthy” way meant sleeping enough to function, and that “sleeping like a teenager” meant being tired in school, and catching up on sleep on weekends, during school breaks or over the summer.

The rhetoric of “I’m so tired” rarely connected with any kind of solution to the problem for students, which makes sense given the reaction from Sally, introduced above, which was typical of what I heard from most teens when I answered their questions how much they actually *should* be sleeping:

KMO: They say if you can [sleep] over nine hours, like nine and a quarter hours.

Sally: That’s impossible!

KMO: It’s a challenge, [students] can do it, but they go to bed early, and they get up late.

Sally: It’s impossible!

The culture of home and messages about sleep

When adolescents talked in the interview about their families, it seemed clear that most families echoed the value of achievement I observed at the high school. Whether “getting good grades” meant straight A’s or simply passing the core classes varied from

teen to teen, but in either case a certain level of academic achievement was valued at home. Achievement in other pursuits was also valued by families, especially sports participation or other activities that might lead to future success for the teen, often in college. Families, especially but not exclusively Hispanic families, also valued teen time spent with the family. This translated into family parties and trips down to Mexico that occurred with regularity for some teens, and even directly affected the ability of Gabriella, a 15-year-old Hispanic female, to break a curfew set by her mom, because of the proximity of other relatives' homes:

Gabriella: We all live on the same block, my Nana, lives across from her mom, and then right next door is my cousin's family, and then over here's my Tio, over here is cousins, and there's my Tio next door, at the corner is Tio and my cousins and everyone like that, and I live a couple streets down, and then my other Tio, he lives a couple streets down, and we're all in the same area.

KMO: Sounds nice.

Gabriella: At times.

KMO: At other times you can't leave your house because everyone is watching you?

Gabriella: Sneaking out of the house at night? They always know... They saw me coming out of my window!

Household structure often affected teen sleep in this population. As a magnet school, the high school was not required to provide transportation to all teens attending the school. How students got to and from school was definitely affected by whether they lived with just one parent or two, whether they had older or younger siblings, and what kind of occupations their parents engaged in. Household structure also affected the type of after school activities the teen could pursue. In a relatively sprawling Western city like the one in which I did my fieldwork, transportation remains a big issue, with bus access to some, but not all, places. Teens in my study were all under 16 years old and therefore did not

have drivers' licenses, limiting their ability to move about the city for activities without parental assistance. This transportation reality had an impact especially on teen wake times in the morning, as students who lived further from the school generally had to get up earlier to get a ride or catch a bus than students who live nearby. In the quote below, Isabella, a 15-year old Hispanic female involved in mariachi (a traditional Mexican music ensemble) and soccer, was already beginning to change her schedule because her mom would like her to take the bus, but it seems that even 5:30 may not be an early enough rise time if waiting for and riding a bus were factored in.

KMO: What time do you get up in the morning?

Isabella: Lately, it's been 5:30, but before it was around 6:45...because there was just not enough time for me to do all the things I have to do. My mom wants me to get used to waking up at the same time every day. I have an alarm [it goes off and] I go and wash up and do whatever, brush my teeth, get set, go feed my dogs, come in, eat breakfast, make sure my brother and sister are awake, I go wake them up, then I basically get all my stuff together...my mom [drives me to school, and I get there] almost exactly when the bell rings. Almost 8.

Family values of achievement in academics and extracurricular activities, and a focus on time spent with the family definitely shaped after-school activities for teens in this population. For teens who had younger siblings, or whose parents ran their own business, after school was often a time to go home to help with child care or business preparations. For others who were the children of single parents, after school was a time to go home and work on homework or play video games, calling mom or dad to check in. Still others had after school activities in other parts of town, but this typically required a parent with a flexible enough schedule that they could come to pick up their child at 3:30 pm or so to ferry them to the next activity. Staying at school for after-school activities

required less in the way of parental activity immediately after school (although it may require a later pick-up) and this was a popular way for students to get involved in sports. With such a large school, however, tryouts for most sports were competitive. “Making the team” represented real talent and students showed off their team pride by wearing team-specific shirts or jerseys on game days (often once a week during the season for their particular sport). Staying after school for sports or other activities also impacted teen sleep. Teens could arrive home as early as 4:00 to 4:30 pm if they came straight home, but if they did not return home until after their weekday activities, it might be as late as 9:00 to 9:30 pm. Ellie, a 15-year-old White female who took several types of dance and played soccer, explains:

Ellie: School ends at 3:30, and I have my dance class, and my dad drops me off there and then at 6:30, I have my soccer practice, until 9...every day except for Sundays. [Dance is] Monday through Friday. When [my parents] pick me up from soccer practice, they usually get me something to eat or if we're home earlier then my mom will just make something. When I get home, I take a shower and then after I get out of the shower, I'll do my homework. And then if I'm done with my homework, early enough, I'll get on the computer for an hour, but if I have too much homework, then I'll finish my homework.

KMO: And what time do you try to go to bed?

Ellie: Before 11.

On weekends, teens engaged in many of the same activities and pastimes that occupied them during the week, only sometimes with fewer time constraints. Adolescents felt they had more control over their time on the weekend, and that they often had more time to do what they wanted, even as their weekend fills up with band competitions, soccer or basketball games, trips to see family in town or across the border in Mexico, and other

commitments. Many teens, often but not always the males, described following their preferred schedule on the weekends – staying up until 1 or 2 am, then sleeping in until 10, 11 or 12 the next day. Some teens did have rules set down by their parents about when they should go to bed, but these were often more enforced on weekdays rather than weekends. As I talked to participants in my study, I noticed a definite continuum of control over sleep. For a few teens, parents almost completely controlled their bedtimes (and sometimes wake times). Other teens completely controlled their own schedules, and many fell in between. One who fell more toward the “controlling his own schedule” end of the continuum, especially on weekends, was Patrick, a 14-year-old White male who was an avid skateboarder, who commented, “Weekends? I stay up ‘til, like, 3 and then I sleep ‘til 11 and just skate all day.”

For a large number of participants, however, their preferred sleep schedule and Patrick’s focus on just one activity was not possible on the weekend. This was often due to a combination of parent and teen focus on achievement coupled with a teen desire to engage in social activities with friends. For example, Mona, a Hispanic female involved in dance, orchestra and a local teen newspaper, describes her long Saturdays, starting at 6 am and continuing until 2 or 3 am Sunday morning:

Mona: ...on Saturdays I actually have to wake up kind of early, like around 6, ‘cause I have Junior Strings on Saturdays...so it takes about maybe half an hour to get ready and leave, and it takes about an hour to get over[there], it’s far on the east side.

KMO: So how long is that practice for?

Mona: It ends at 10...then after that, I get a brunch, lunch thingy. And then we go and do errands and then we, like, go home and do whatever...I try to do my homework, but sometimes I always do half of it, but then do the other half on

Sunday, so after I'm done doing the house, I'm like, do everything else I'm supposed to do: finish taking pictures, um, finish writing down a paragraph or whatever [for work]. After dinner, I get to relax.

KMO: Is that like, watch TV or a movie?

Mona: Yeah, or play on the Playstation, we've got the Wii, it is so awesome...there's always Tony Hawk...It's a skateboarding game, you have to go on missions and stuff like that. Missions where you go and knock off some heads and whatnot...Friday and Saturday, I go to bed late [2 or 3 am]. Fall asleep at the computer, or at my laptop, or with my phone. Sometimes, my mom has actually come in and found me asleep with like, the laptop and the phone on at the same time. So, like it is? IM's keep popping up, "Where are you? Where did you go? What are you doing? Oh my God, she's not asleep, right? Hello? Hello? Hello?" Bye!

Other teens had their weekend sleep time limited by parental attitudes. For example, Javier, a 15-year-old Hispanic male who liked to skateboard, describes his dad's perspective on him sleeping in, which he linked to a certain kind of achievement, excelling in the military:

KMO: So, who, or what, affects when you go to bed and when you get up on the weekdays?

Javier: My dad. He's, like, really strict and he always wants me up before seven. He sometimes will let me sleep 'til 10 or 11.

KMO: On weekends?

Javier: Yeah.

KMO: Why do you think your dad always wants you to get up?

Javier: 'Cause he says, like, real life is not like where you get to sleep in like that. You usually have to get up, especially, if you go to college, you have to get up at, like, early...He really wants me to go to West Point.

Planning and rehearsing for a quinceañera, a lavish, wedding-like party thrown for Hispanic, Catholic girls on their 15th birthday, also shaped teen sleep for Hispanic girls and boys, especially on the weekends leading up to the party. This party combined time with family and family sense of achievement – presenting your beautiful 15-year-old

daughter in society in a lavish way, in order to make a statement about the family's place in society, as well as their means to throw such a party. For example, Olivia, a 15-year-old Hispanic female involved in mariachi and soccer, talks about some of the things that need to be done, including invitations, buying the dress, and the dancing practice that takes place several weekends in advance of the actual event.

Olivia: my Quinceañera is going to be [coming] up in August... and then I need to draw – do the invitations and do – and order my dress.

KMO: And then you do – you do dance practices but that would be a lot closer to the actual Quinceañera?

Olivia: ...I think, like, after May, we'll start practices, 'cause, like, you know, some people can't go to some, so those extra days we'll make up for those days and I don't want it to come off crappy, or whatever... Maybe twice a week. Twice, or three times, a week.

Reflecting the teen value placed on social activities, many participants, some males as well as females, talked about spending the night with friends as something that kept them up late on the weekends. I asked Sally, a 14-year-old White female who played volleyball, "Do you stay up later on Saturday nights?" and she replied, "Yeah, probably at my best friend's house we would stay up till 4." Even with late-night sleepovers, value placed on "family time" sometimes meant that church affected teen wake times on the weekends. Sally continues, "On Sundays I wake up at 7:45 and get ready for the 8:30 Mass. And then usually we just come home and hang out that day, maybe do some housework and get cleaned up."

Messages about sleep from parents, lived experience and the media

For many teens, home was a place where they embodied how to sleep in a healthy and/or “teenage” way. Parents’ advice (and sometimes nagging), the teens’ own experience, and the media all provided at least occasional input on how teens should be sleeping. Despite stereotypes of teens paying more attention to friends than to parents, many parents’ messages about sleep came through to teens. These messages seemed particularly effective if the parent had some medical knowledge – for example Mike’s mom, “My mom, she’s a registered nurse. She would tell me what sleep does for me and how it helps like, diseases and colds because when your body’s sleeping it’s not hurting, it’s warm.” Although this message got a bit garbled, Mike, and others who relied on parents or family members with medical knowledge, clearly internalized the fact that sleep could have a positive impact on his health. Many other parents also stressed that teens needed to go to sleep to be able to wake up the morning, and to facilitate achievement in school, like Norma’s mom and dad:.

...like, he says, “You’ve got to go to sleep, or else you’re going to be tired,” or “you’ve got to go to sleep, or else you’re not going to do well in school,” ,” or “you’ve got to go to sleep,” you know? I’ll be, like, “Dad, be quiet.” And my mom... She’ll make us go to sleep at 10. She says, “You’ve got to go to sleep because you’ll be all late for school and won’t be able to wake up...(Norma, 15)

In addition to relying on information from others on sleep, teens used their own experiences of sleep to figure out how much sleep they needed, and to weigh the consequences of sleeping too little or too much relative to their “ideal” sleep duration. Given this, a number of students mentioned that they relied on their own experience to

gain information about sleep. Gabriella, introduced above, said, “I hear people’s views and stuff, or [have] my own opinions, but then I form my own opinions more from observation and experience.”

Perhaps the most common way teens learned about sleep gives support to the notion that sleep is a cultured behavior: learning about sleep as a teenager springs from interactions with everyone around you, every day. Adolescents may not notice that they are adding to their store of knowledge about sleep as they listen to their parents nag them, or their teacher make an offhand comment, or they watch a sitcom on TV. But it all adds up. Katie, a 14-year-old White female who participates in marching band, and Olivia, introduced earlier in the context of quince planning, both express that they learn about sleep from a variety of sources, like many teens in my study.

I don’t know, I watch a lot of PBS shows about, like everything, and so I think I saw one on sleep, but I’m not really sure... But, I’ve always heard in health class last year, like sleep helps you, like makes you more alert. [Parents] say it’s good, but that’s about it. (Katie, 14)

Olivia: ...sometimes my mom she’ll tell me, like, “If you go to sleep earlier, you’ll be able to get up, like, early in the morning and be good at school.” Yeah, but I think it’s stupid. I think it’s like -- Maybe it does matter but it doesn’t. I don’t really see a difference.

KMO: Do your teachers talk about sleep at all?

Olivia: Only when tests, like, finals and...anything like that comes up.

Several teens said they were “subliminally” affected by portrayals of sleep in the media, while others, like Ana, , a 15-year-old Hispanic female involved in many activities, commented on these portrayals directly as a way of seeing herself, as a teenager, on TV:

Ana: I'll watch TV shows and I'll watch how teenagers my age fall asleep in class because they were up on the phone all night and I just think, "Oh, that's me, too, some days."... Like, I never see...TV shows with adults in them when they fall asleep with that. It's only teenagers because I have no idea why most, like, more adults than teenagers fall asleep or get tired more. I have no idea.

KMO: So, you watch shows that have, like, a set of characters who have a range of ages in them and it's always the teenagers who are always, you know –

Ana: Yeah, always the group of teenagers that fall asleep in class or have something on their minds and that keeps them up or little things like that. Then it's funny 'cause I'll be watching them and think, "Oh, my gosh, that's me in class."

The sleep industrial complex

In addition to general portrayals of sleepiness in the media, some organizations, both those whose business is providing information and those whose business is selling products, have made a concerted effort to draw attention to the problem of sleeplessness in American society and to proclaim it doesn't have to be that way. Mooallem (2007), terms this collection of individuals and organizations who are selling solutions for poor sleep the "sleep industrial complex." It is medicalization with a retail twist. Mooallem quotes a vice president of a large company that manufactures steel springs for mattresses as saying, "Create the pain [of poor sleep], then give them the solution." Which, for this vice president, is clearly a better mattress. While teenagers typically are not core mattress consumers⁶, they are affected by two other aspects of the sleep industrial complex – direct to consumer (DTC) advertising by pharmaceutical companies, touting the latest

⁶ However, in a meeting of the sleep industrial complex and the social networking frenzy, I documented a lengthy exchange among several of my friends in their late thirties about organic mattresses, which started with someone making fun of the concept, and concluded with this summation by one of participants as to why he purchased an organic (or perhaps "all-natural", he wasn't sure) mattress: "Long story short, we figured we didn't want to spend 1/4 to 1/3 of our lives just a couple thin sheets away from off-gassing petrochemical foam [of the Tempur-pedic mattress]. Admittedly, there was nothing reliable that we could find to show harm from off-gassing - we just figured it wasn't something we wanted to risk."

sleeping pills, and marketing from high-caffeine beverage companies aimed directly at the adolescent audience.

Referencing the pharmaceutical industry “turning ordinary ailments into medical problems,” Moynihan and colleagues (2002) deride the “disease mongering” of hair loss, irritable bowel syndrome and erectile dysfunction. Although their article predates the popular-press rise of “excessive daytime sleepiness” (Kroll-Smith, 2003) I am sure they would also be willing to address insomnia (and sleepiness more generally) across the lifespan as fodder for disease mongers. Between 2001 and 2006, the number of prescriptions for sleeping pills rose 53%, to 49 million in 2006. Unlike a mattress, or some other (free) means for improving sleep, such as addressing sleep hygiene by making sure rooms for sleeping are dark and cool, etc., sleeping pills take the work out of getting better sleep. While teens do not take these medications⁷, they do see the advertisements, as Eric, a 14-year-old White male active in marching band, and Monique, a 14-year-old African-American female involved in drama, describe:

Eric: Just those, um...insomnia commercial or that Abe Lincoln’s playin’ chess and the beaver’s there... Yeah, and then the Lunesta or whatever it is

KMO: But you don’t know anyone who’s actually taken them, you just see the ads on TV?

Eric: Yeah

⁷ Teens did say they had taken medicines like Benadryl, Tylenol PM, or other similar over-the counter medications to help them sleep on occasion. This was rare, however, and they mostly took this type of medication to treat symptoms other than sleeplessness.

KMO: Anything from media, like movies or TV or anything?

Monique: Hmm, well, oh like commercials like Lunesta, they don't help you out

KMO: Someone was like "that one where the beaver is playing chess with Abe Lincoln..."

Monique: Yeah, that one...

KMO: People know this one

Monique: Yeah that was the only one I've seen, like in the media, maybe on 20/20 but that's like, rare.

The extension of the sleep industrial complex to include wake-promoting items such as high-caffeine drinks and other caffeinated products represents a new direction in theorizing this creation of a market for the treatment of night-time sleeplessness and daytime sleepiness. Caffeine-containing beverages, like sleeping pills, do not treat the root cause of inadequate sleep, just its symptoms. According to Giddens, "In conditions of modernity...the media do not mirror realities but in some part form them" (Giddens, 1991 p. 27). As these teens mature into adults who may continue to be sleep deprived, they will carry with them the reality of a quick fix to sleep problems – sleeping pills and caffeine - presented to them by the media. The commodification of sleep encouraged by the DTC advertising of the pharmaceutical companies and also omnipresent high-caffeine beverages is mirrored in the social worlds of youth by something that they already understand: the value of wakefulness. Ambien and Lunesta give those who take them a promise of restful sleep, but they also promise better wakefulness the next day (Mooallem, 2007). Marketers of caffeinated beverages and other products aimed at teens realize that adolescents often do not have the "eight hours to devote to sleep" recommended by sleeping-pill marketers, so instead they focus on allowing adolescents

to achieve wakefulness on their own schedules through the (not always judicious) use of Monster, Rockstar, 5-Hour-Energy, and of course, ordinary soda.

Though adolescents are not sleeping pill consumers (yet), they already value wakefulness, and many used caffeine to allocate this wakefulness according to their priorities. Before school, homeroom, lunch and after school are times for wake, as are weekends when valued social time with friends or activities beckon. Acceptable times to sleep include late at night, after checking in with social networks via phone and internet, on the weekends when time with friends or other appealing activities are not available, and sometimes during class. Worthman (2008) suggests that although national statistics suggest that many segments of the U.S. population (adults and teens included) are getting too little sleep, a majority of individuals tend to report getting enough sleep “because they are getting the amount they want given the attractions of rewarding activities” (Worthman, 2008 p. 311)

Teen perceptions of sleep need and “sleeping too much”

When asked how much sleep they thought they needed on weeknights and weekend nights, adolescent participants gave varying answers. Most said they needed more sleep on the weekend, which reflected reality as most teens obtained more sleep on the weekend. Overall, teens felt that they would get enough sleep if they could sleep 35 more minutes on weeknights (7 hrs 48 minutes vs. the 7 hrs 13 minutes they actually got). Interestingly, teens said they only needed a mean of 8 hours 12 minutes on weekend

nights, which was 16 minutes less than the mean sleep obtained on weekends. For both weeknights and weekend nights, the median sleep desired by teens was 8 hours, which seems to reflect a common perception that 8 hours is “the right amount” of sleep.

When I asked teens if it was possible to “sleep too much,” they were almost evenly divided. Many said “no” with a surprised laugh, while the other half thought of their own experiences for a moment and said “yes.” As I will discuss in the next chapter with reference to the question “Is it possible to catch up on lost sleep?” an answer of “yes” to “Is it possible to sleep too much” probably reflects teen’s experiences of feeling over-tired when they wake up after sleeping for a long time, and a message of “moderation in all things” that frequently comes across, particularly in health messages in the United States. Gabriella, introduced above, explains how she tries to balance wanted to sleep more, and not sleeping too much, “You always want more sleep, but I don’t think that’s a bad thing, especially if you’re not going anywhere. I don’t know. What I’m trying to say, is too much of anything is bad... If I sleep an entire day, I can’t sleep when I need to.” I also got a sense from teens that they feel that sleeping too long disrupts your schedule, which Gabriella refers to, as does David, also introduced above:

Well, once I was up all night at a party and I got home at six in the morning and then I went to sleep, probably, at 7 and then I woke up at, maybe, six the next morning, and that might have been too much. That’s, like, 23 hours. I felt – I don’t know – it kind of threw off my schedule of – yeah, it was weird. I went to bed really late that night and then it was like jet lag. (David, 15)

Finally, several adolescents equated sleeping too much with being lazy, although they used this word in two different contexts. Some, like Mike, a 14-year-old White male who participates in mountain biking and drama, stressed that after he had slept for a long time, "...I feel like, lazy, like I don't want to get up, like I just want to lay there in bed, I don't really want to do anything." Others, like Marcus, introduced above, used "lazy" to emphasize the low value he (and his parents) placed on sleeping "too much." Although he's talking about rising at 11 am in this quote, he seems to be bucking the "teenagers sleeping until noon" stereotype.

"...it's impossible for me to just sleep a lot. Like, the latest I can sleep in is like 11 o'clock, a lot of people sleep in 'til like, 3 or 4, but I can't do all of that. I can't be in bed all day...I can't sleep in, it feels good, but then it feels too—I don't know, too lazy? I wasn't raised like that, I wasn't raised to be lazy." (Marcus, 15)

Conclusion

Based on the factors that affect teen sleep and their sources of information about sleep, it is clear that a variety of cultural values shape teen sleep in this population, and these values contribute to teens' need to *negotiate* their sleep. Family focus on achievement, both in and out of the classroom, mean that teens often seek to balance classroom performance and attention to extracurricular activities, but their sleep is influenced by other factors as well. Families value time with their teens, so youth may balance this family time with the value they place on spending social time with their friends, while still trying to "sleep enough" on weekdays and weekends. From their family, teens learn to embody *normative* ideas of "healthy" sleep, often defined by certain bedtimes or wake times. In addition to healthy sleep, however, teens try to achieve *pragmatic embodiment*,

fulfilling their social role by sleeping like a teenager. At school, sleeping like a teenager means engaging in the discourse of “I’m so tired” and pledging to catch up on sleep on the weekends. This is easier said than done, however, as teens may get to sleep in a little on the weekend, but often find their weekends filled with activities chosen by themselves and also by their families. Teens strive to balance being a good son or daughter, being a good athlete or actor or journalist or club member, being a good friend, and perhaps being a good gamer or skateboarder in their spare time, leaving sleep as a loser in the balancing act of teen life. But when asked about how much sleep they think they *need*, teens come up with a figure that is not much more, on average, than they actually getting. Although they probably need more sleep, a value on achievement emphasized both at school and at home serves as an unintentional cultural barrier to sleep, making too much sleep seem “lazy.”

Given the context of teen perceptions of sleep, as shaped by the cultural and environmental influences of high school, home, and media messages, we turn now in Chapter 5 to the influence of a particular, widespread and insidious environment occupied by teens across the U.S. and across the world, often 24/7 – the technology environment.

CHAPTER 5: THE PERSONAL TECHNOLOGY ENVIRONMENT AND ADOLESCENT SLEEP

Biocultural anthropologists often consider the environment as one factor that shapes human behavior. The physical and social environment both provide opportunities as well as constraints on what an individual or a population can do at a given point in time. This is certainly true with regard to sleep. Although I did not measure features of the physical environment as part of this dissertation, it is clear that light levels, temperature, noise and other factors impact sleep. We have also seen in the previous chapter how aspects of the social environment, particularly the educational system that sets up high school curricula and schedules, and the family, which sets parameters that influence individual teen behavior, directly affect sleep. The technology environment is a bit more nebulous, however. Technology seems to be everywhere – many teens seem almost literally glued to their cell phones and Ipods. In many ways, the technology environment is an extension of both the social environment – a virtual “place” for spending time with friends, mentioned in the previous chapter as a key adolescent value – and also the media. Portable media present teens with a way to interact with friends, for example, “Look at this picture of my cat I took with my phone!” (on the tame side, given the recent media frenzy about “sexting”) OR “Hey Honor, you have to listen to this song!” Cell phones, Ipods and other technology also give teens a way to escape events seen as boring (for example, calling someone on the cell phone while walking or waiting at the bus stop, or surreptitiously texting under the table in science class during a lecture or film) The internet allows access to sites where youth can build their identities while strengthening

friendships, like Myspace in the mid-2000's, and now Facebook. These sites are also places where they can instantly share their thoughts and feelings with hundreds of friends – and get instant feedback from their friends who are also online.

Given the lure of these multiple forms of technology, it is not surprising that cross-sectional research studies have linked many types of technology use with poorer sleep (Van den Bulck, 2003; Van den Bulck, 2004; Van den Bulck, 2007). In addition, experimental studies have shown that exposure to bright screens too close to bedtime negatively impacts sleep (Dworak et al., 2007; Higuchi et al., 2003; Higuchi et al., 2005). While large studies of youth technology use exist (Rideout et al., 2010), they calculate hours per day of technology use, but do not ask questions like, “How many teens turn off their cell phones when they go to bed at night?” Although there are still many ways I would like to improve my technology data collection, this study is the first to include prospective technology diaries, completed along with sleep diaries. These adolescent self-reports provide a much more in-depth picture of technology use around bedtime than is known from other studies. This chapter will first present descriptive information about teen technology use and its relationship to sleep, with a focus on the voices of the teens themselves. Gender differences in sleep will then be discussed, as teens often cite technology use as a factor that influences sleep along gender lines, with a focus on how teen perceptions match up with actual data from this population. Finally, this chapter will conclude with an examination of the technology diary data to see **how late-evening technology use interacts with teen sleep in this population of adolescents**, specifically

testing to see if teen technology use within two hours of bedtime affects lights out (bedtime), sleep onset latency, total sleep time or sleep efficiency that night.

Teen technology use and its relationship to sleep

Most teens used multiple forms of technology in their daily lives, but some were more connected than others. Gabriella, a 15-year-old Hispanic female who took bellydancing lessons, made many comments as she filled out a technology questionnaire at the beginning of our interview. I scribbled down what she was saying, awed by so much technology use. These are my field notes, noting her comments about using various forms of technology:

Computer – non-homework use: sometimes on all day, 4-5 hours – on as soon as [she gets] home from school, off for a few minutes to eat dinner, back on, but if [she] has lots of stuff to do, barely on at all.

On the phone until 1 AM, phone is never off but calls/texts are intermittent, [she] wakes up at night and texts (though her phone screen is broken now, so can't text right now, only call)

Use a landline phone once in a while but she says "I don't even know the number to that phone." No landline use on weekends (free cell [minutes] weekends)

TV "Oh my god, if I'm not on the computer I'm watching TV" 7 hours of TV "That's as long as I'm [ever] home" Sometimes I'm home for 2 hours.

Lately on MySpace a lot but usually hate it "It got really dumb." [It's] cool during summer, but 10 year-old girls trying to be, like, sluts, and the popularity thing is dumb too. "Oh my god, I'm not on your top 8 [friends] why am I not on your top 8?"

She is not atypical, though. I talked to many students who had an iPod earbud in one ear (or both). I usually asked them to take the earbud(s) out, since I saw their presence as a

sign of disrespect, although I'm not sure they were even aware of it. I also had a student tell me that during our interview he was fighting the urge to text his friends, because he could feel his phone buzzing in his pocket as we talked, but he wanted to give me his full attention.

Teens reported quite a bit of multi-tasking, usually involving doing homework while engaging in other activities like checking their Myspace messages or instant messaging friends, talking on the cell phone, listening to music or watching TV. In this way, teens in this sample are typical of the broader U.S. population, as a recent survey found that young people ages 8 to 18 spent an average of 11 hours consuming media content per day. Due to multitasking, however, they packed this 11 hours of consumption into 7.5 hours (Lewin, 2010). The article describing the results of this study indicated that teens were using technology practically every waking minute when they were not in school...but my work reveals that they are also using technology in school, either openly or covertly, depending upon the tasks they are supposed to be completing at the time.

Teens used technology at all hours of the day and night, but evenings were often a good time for teens to make calls to friends and spend some time on the internet. When I asked what actually kept them up late, the answer was often technology, specifically technology as a way to maintain social connections, as described by Isabella, a 15-year-old Hispanic female involved in soccer, mariachi and an organization for military teens:

KMO: So what time do you usually get to bed on the weekends?

Isabella: If I'm not on the phone, it's about 11:30, probably the same—

KMO: What if you are on the phone?

Isabella: I could be on the phone as early [late] as 2 in the morning, just because I have friends in Hawaii, and they call me and they're like, "Are you up?" for people who are out of state, it's hard to say, "I know we haven't talked for a while, but, it's getting late over here. I need to get to bed."

When I asked teens about their weekday routines and sleep, technology use came up a lot in the conversations. By "technology" I mean electronics, such as the computer, television, stereo, MP3 player, gaming system and cell phone, all of which may personally belong to the teen, or may be shared with other family members. I did ask about home (landline) phones and usually got a puzzled look, especially if I used the word "landline." Teens simply did not know what I was talking about. I also asked about CD player use, and a few of my participants still had this technology, but not many. Almost all had moved to Ipods or some other kind of MP3 player. See **Table 9** below for a summary of the percentage of teens in my sample (n=42 for this questionnaire) who had various technology items in their bedroom, in a location where they had access to them after 10 pm, and also a report of which items they actually used after 10 pm.

Table 9: Technology access and use among my participants, gathered from a brief questionnaire (N=42)

	In Bedroom	Access after 10 pm	Use after 10 pm
Cell phone	83%	83%	64%
TV	79%	76%	43%
MP3 Player	71%	74%	31%
Stereo	71%	67%	29%
Computer	50%	71%	57%
Gaming System	45%	50%	29%
CD Player	45%	41%	17%
Other phone	26%	31%	5%
Portable Digital Assistant (like Palm Pilot)	10%	10%	5%

“Technology” also references different ways teens could use these electronics, like emailing, instant-messaging (IM or AIM), social networking (most often on MySpace, discussed below) or game-playing on the computer, and talking and texting on the cell phone. In addition to documenting their own technology use, teens also referenced technology when talking about gender differences in sleep, discussed in more detail below.

For many teens, the ideal weeknight included “getting everything done,” both in terms of required activities and taking time to interact with friends or perhaps even for themselves. Ana, a 15-year-old Hispanic female involved in many activities, says, “Like, yesterday, I went to bed at 9:30. And that’s because I did everything that I wanted to do. I got all my homework done, I went on the computer, I talked on the phone, and, yeah.” These

priorities were echoed by many in my sample, especially the girls, who often included both some time on the computer and time on the phone as important parts of their weekday afternoon/evening.

As Isabella, who stayed awake to talk on the phone to friends who lived out of state, illustrates, using the cell phone was a common way that teens pushed back their bedtime, with or without their parents' knowledge. Honor, a 14-year-old Hispanic female involved in the Step-dancing team, explains:

[Bedtime is] late, like between 10:30 and 1 o'clock in the morning, even if it's a school day....it depends who I'm talking to on the phone, or if I don't have homework, if I don't have homework, I'll probably go to bed early, but if I have homework, I'll do my homework and talk on the phone and just, yeah. Then I just stay up. I start getting a little bit tired, but I just stay up anyways, even though I should be asleep, but when I get really tired, I'll stay on the phone. (Honor, 14)

It is not just girls up late on the cell phone, however. Some boys are up talking, too, like Ignacio, a 15-year-old Hispanic male who plays pickup soccer and basketball games with friends:

KMO: What time do they [parents] tell you to go to bed?

Ignacio: Around 9.

KMO: Is that when your brother and sisters are...going to bed?

Ignacio: Yeah.

KMO: Do you have your own room or do you share with anybody?

Ignacio: I have my own room.

KMO: OK. So, you're able to, like, go to your room and, kind of, hide out...

Ignacio: Yeah. Or, like, we talk on the phone at night.

KMO: Do people call you or do you call them?

Ignacio: Yeah, they call me.

KMO: ...like, people from other -- other, like, cities, states, or just local people?

Ignacio: Just local.

KMO: Hmm. So, that, like, maybe, starts at 9, or so, and – when everybody else is – when your brothers and sisters are going to bed ...OK. And what time do you usually get to bed on the school nights?

Ignacio: 11.

Several girls (Billie, Gabriella) also reference talking with their boyfriends late at night

In addition to the cell phone, the computer, gaming system, and the TV were commonly used technologies around bedtime, with the TV especially being used as part of a number of teens' "going to bed" routines.

Though teens did not talk too much about using technology in the morning, the cell phone was the exception. Gabriella, introduced above, says "I don't wake up for anything except for my cell, that's how my mom wakes me up." Ana, introduced above, talks about texting first thing in the morning, "But I've noticed that, when I wake up, my, like, my hands are more slower, 'cause I'll wake up and I'll start texting... and, when I text, I'm not as fast as I was when I was wide awake. However late-night (and early morning) chatting/texting is by no means universal, several teens expressed sentiments like Mia, a 15-year-old Hispanic female who danced Folklorico, who said "I don't really stay up late talking on the phone. Like, I'll just be, like, "I have to go -- go to sleep."

For some of these adolescents, the weekend generally brought more technology use, especially for teens whose parents restricted use of electronics during the week. Jason, a 15-year-old White male who plays in the orchestra and runs track, explains that his

computer use is not restricted by his mom on the weekends so "...I'll be on that a lot and that's basically all I do." Events like the purchase of a new video game could also cause weekend technology use to spike (and sleep to decline), as Connor, a 14-year-old White male who plays in the marching band indicates as he describes staying over at a friend's house on the weekend:

Connor: Usually, if we just got a new videogame, we...play basketball and play videogames. We have actually [not] gone to sleep one time. That was pretty fun but, usually, it's never beyond 5, usually, in the mornings. It's, usually, before 5 and after 2.

KMO: So, if you were going to bed like between 3 and 4 in the morning and you sleep in until what time on Saturday before somebody wakes you up?

Connor: No one wakes us up 'cause they know that we were annoying all night 'cause we were up playing videogames. So, they don't want to wake us up. My [one] friend can definitely go 'til after 12. Me and my other friend tend to wake up together around 9. We hear each other wake up and go, "What's happening?!"

KMO: Mm-hmm. Do you wake up and go, "What's happening? Oh. It's only 9," and then you go to sleep or do you actually get up then?

Connor: We get up and play videogames...

While most teens embraced many forms of technology (often at the same time), the novelty was already wearing off for some on the social networking site MySpace. During my fieldwork, as previously mentioned, MySpace was at the top of the social networking pyramid. In the Fall of 2006, many of my participants used MySpace messaging in place of email, IM or even talking or texting on the cell phone as a quick communication tool. Marcus, a 15-year-old African-American male athlete who participates in multiple sports, comments pragmatically that, "...if I want to talk to people other than her [my girlfriend], I'll just talk to them on MySpace. It's like an easier transition of in and out for everybody instead of like being on the phone."

Teens who were already rejecting MySpace, however, mainly perceived it as a big waste of time, or as something that just amplified the drama of high school. In my notes after an interview with Annie, a 15-year-old soccer player, I wrote:

Annie says she's not on the computer that much –she's **on**, but not on 24/7. She thinks MySpace is kind of stupid and boring. People will say "I just redid my profile", and she thinks, good for you, spending 7 hours on MySpace. What she likes to do is work on videos and pictures, both taking them and photo-shopping/processing them. She checks messages on MySpace, but she says "I don't talk to people –I don't care." She gets on the site and get off. She might stay on but only if she's extremely bored. Of MySpace, she says "everyone's addicted, it's just a website."

Gender differences in sleep

Although the section above addresses general teen technology use and its relationship with sleep, stereotypes about who uses a particular kind of technology abound. Girls like to chat on the cell phone. Boys stay up late playing video games. But what are teens' specific perceptions of girls vs. boys sleep, and how does gender really affect technology use and sleep in this population?

When I asked teens, "Do you think girls get less sleep than boys?" most responded that yes, girls did sleep less, although data collected from sleep diaries in this population revealed that while this might have been the case on weekdays, girls actually slept more on weekends. See **Table 10**, below, for a quick summary of gender-related sleep data; gender differences in sleep will be addressed in more detail at the end of Chapter 6, on normal sleep in this teen population.

Table 10: Mean weeknight and weekend night sleep for girls and boys in this population

Teen perception: do girls sleep less than boys?	Mean weeknight sleep, girls (n=19)	Mean weeknight sleep, boys (n=16)	Mean weekend sleep, girls (n=20)	Mean weekend sleep, boys (n=20)
Yes	7 hours 7 mins	7 hours 19 mins	8 hours 40 mins	8 hours 15 mins

Many teens, both girls and boys, thought that girls slept less for two reasons 1) Because they had (or perceived they had) greater social obligations and 2) Because they got up earlier in the morning to “beautify” themselves. Isabella, introduced above, explained both the social obligations, in the form of “drama,” and also physical differences between girls and boys by saying, “Because one, guys don’t have to deal with as much drama, which makes the girls stressed, and if the guys have drama, they don’t care about it as much, and physical reasons...like Aunt Flo coming to visit.” However, differences in mean sleep time between girls and boys in this sample did not differ significantly by one-way ANOVA on weeknights ($F(1,33)=.741, p=.396$) or on weekends ($F(1,38)=.490, p=.488$).

Data collected from technology diaries on evening cell phone use (beginning 2 hours prior to the teens’ recorded bedtime, typically between 8 and 9 pm, as more than 51% of bedtimes were in the 10 to 11 pm range on weeknights and 43% were in that range on Sunday nights) lends some support to Isabella’s comment about girls engaging in more social drama, at least on Sunday night (see **Table 11** below). On weeknights, there is no significant difference (using chi-square comparisons) in this population between the number of girls and boys using cell phones, either to talk or to text. On Sunday night,

however, all six teens who talked on the cell phone were girls, as were 2/3 of those who sent and received text messages. The difference for Sunday-night cell phone talking, by gender, is marginally significant by chi-square, $\chi^2(1) = 3.429$, $p=.064$. Although cell-phone using females spent longer using technology on Weeknight 1 and Sunday night, these differences were not statistically significant by one-way analysis of variance (ANOVA), even after log transformation of all technology use values > 1 minute.

Table 11: Male and female cell phone use 2 hours prior to their reported bedtime, from technology diaries

Night	Sample Size: Teens reporting time on the cell phone	Mean minutes using technology, if a cell phone user		Talking		Texting	
		Males	Females	Males	Females	Males	Females
Weeknight 1	13	54	93	5	5	2	2
Weeknight 2	14	74	71	5	6	2	2
Sunday night	8	60	75	0	6*	1	2

* Marginally significant between males and females by chi-square, $p=.064$

Regarding who stays up later, Rachel, a 14-year-old Native American and White female who plays in the orchestra, points out that in her experience, bedtime depends more on activities and personality than gender, "... it has to do with sports, and there are guys who are here till, like 8'o'clock at night, and there are guys who go and are online more than us, it all depends on like, who they are, I guess."

Lucinda, a 14-year-old White female who participates in dance and the local teen

newspaper, even advanced a theory of how boys and girls differed in their social (and possibly physical) dependence on sleep, with girls needing more:

I think guys are less dependent on sleep, like just socially, not biologically. I'm sure we are all built to need the same amount, but I know that the guys I know don't go, like, "I'm tired." They don't complain as much, but if they stay up all night to work, or if they stay up all night to play videogames, they will. And girls tend to be like, "Well, I need to get sleep." (Lucinda, 14)

Both boys and girls agreed, however, that the boys had a shorter prep time in the morning. Eric, a 14-year-old White male active in marching band, and Valeria, a 15-year-old Hispanic female who played in several mariachi ensembles, commented:

They might [sleep less], if they want to get up earlier and do makeup & hair and stuff. Like it takes me about 5 minutes to get ready in the morning, cause I just need to put the right clothes on, but takes my mom about 30 minutes to get done. (Eric, 14)

Yes because they have to do their hair, they have to pick out their clothes and make sure everything's perfect and boys really don't care. (Valeria, 15)

An interesting caveat to the near-universal perception that girls get up earlier than boys to get ready for school, though, was the "not me" sentiment expressed by some girls. Both Norma, a 15-year-old Hispanic female who dances Folklorico (traditional Mexican dance), and Sally, a 14-year old White volleyball player, both agree that girls get up early to get ready, but then exempt themselves from that group:

Well, not in my case, in my case, I'm a little unusual, mostly, 'cause, like, all the girls here, they do 'cause they have to put on make-up, they have to do their hair. Like when I had to iron my hair, like, straight, I got up earlier... to get it done. And now I'm just lazy 'cause I've been getting to school late so I'm just braiding it or it or I've been leaving it, like, you know. (Norma, 15)

I think girls would get up earlier so, for lack of a better word, we feel that we must beautify ourselves for the day. I put on my eyeliner, sometimes I won't put on anything at all, I'll just wash my face and do my normal routine and brush my hair and go. I'm not that dependent on makeup, really. But some girls do, they feel more comfortable and will wake up early to put it on. (Sally, 14)

Prospective technology diaries and sleep

As described in Chapter 3, teens kept prospective technology diaries, writing down what type of technology they used, and for how long. Some teens were quite detailed in their diaries, but others listed fewer instances of technology use, or none at all. When I collected the diary packets from teens, I did not prioritize going through their technology diaries, so if they were left blank I do not know if this reflects no technology use on that day or if it means the participant simply failed to fill out the diary. For the analysis presented below, I examined at three weekdays/nights for which I had a technology diary, followed by a night of sleep data, across the 50 diary-completing participants. These were Weekdays 1 and 2 (generally a Tuesday and Wednesday, though in 12 cases, it was a Monday and a Tuesday) and then Sunday. I subtracted 2 hours from the teen's lights-out time and looked for technology use that began in the 2-hours-before-bedtime window. I say "began" because sometimes the technology diary contradicted the sleep diary, recording 3 hours of technology use, for example, putting the teen's bedtime at 11 pm instead of the 10 pm he recorded on the sleep diary. In order to capture the potential differential effects of light-emitting technologies (like computers, televisions or game systems) vs. non-light-emitting ones (like cell phones) I recorded the type of technology teens reported using, and sorted these into "light emitting," "computer only" and "all

technology.” I also recorded the total minutes using technology. **Table 12**, below, summarizes mean and median minutes of technology use on the three nights, and **Table 13** indicates the percentage of technology users who used particular types of technology on various nights.

Table 12: Technology use by teens starting 2 hours before reported bedtime

	Weeknight 1	Weeknight 2	Sunday Night
Sample Size	17	14	13
Mean minutes of use	65	75	62
Median minutes of use	34	63	52
Range of values, in minutes	2 to 240	10 to 180	3 to 180
Teens who also reported technology use prior to 2 hours before bedtime	88%	86%	77%

Table 13: Types of technology used by teens starting 2 hours prior to reported bedtime

	Weeknight 1	Weeknight 2	Sunday Night
Sample Size	17	14	13
Technology types		Percentage using this technology	
Talking on cell phone	53%	71%	46%
Texting on cell phone	24%	21%	15%
House phone	0%	7%	0%
Computer use, unspecified	18%	7%	15%
Email	12%	7%	8%
Instant messenger	6%	7%	8%
Internet	6%	7%	0%
Myspace	0%	0%	15%

	Weeknight 1	Weeknight 2	Sunday Night
Sample Size	17	14	13
Technology types		Percentage using this technology	
TV	12%	7%	8%
Game system/console	6%	7%	8%
Ipod/MP3	6%	0%	0%

Literature suggests that for technology users, lights-out (bedtime) may be later and total sleep time (TST) shorter (Van den Bulck, 2004). Research further suggests that sleep onset latency (SOL) may be longer (Higuchi et al., 2005) and sleep efficiency (SE) may be lower, reflecting more disturbed sleep (Dworak et al., 2007; Higuchi et al., 2003; Higuchi et al., 2005), at least among males, as females were not included in the Higuchi and Dworak studies. I tested the four variables Bedtime, SOL, TST and SE across four conditions listed in **Table 14** below. If differences were non-significant but $p < .200$, I compared male and female means separately to see if the difference might be significant in one gender but not the other.

In order to calculate differences between teens who used technology 2 hours before bedtime and those that did not, I transformed the sleep onset latency (SOL) and sleep efficiency (SE) variables so that they met the assumptions of normality. For SOL I used a log-transform of $SOL+1$, and for SE I applied the arc-sine function, appropriate for percentage variables where many values cluster close to 0% or 100% (Garson, 2010).

Total sleep time distributions were not transformed, as they were slightly skewed, but z-scores for skewness and kurtosis fell within acceptable limits. For SOL, TST, and SE on Weeknights 1 and 2, differences in means between technology users and non-users were assessed using one-way analysis of variance (ANOVA). For Lights Out (Bedtime) comparisons on all nights, and sleep efficiency comparisons on Sunday night, when many values were too close to 100% for effective transformation, I used the non-parametric Mann-Whitney U-test for between-group comparisons, instead of ANOVA.

When calculating correlations between the four variables and minutes of technology use, I selected all technology-use values >1 minute and log-transformed these values.

Correlations between Lights Out (Bedtime) on all nights, and sleep efficiency on Sunday night (the non-normal distributions), and minutes of technology use were expressed using Spearman's Rho, while other variable combinations used Pearson's r, controlling for gender. Examining technology-sleep relationships over three weeknights produced some significant findings on Weeknight 1 and Sunday night, summarized in **Table 14**, below. In the description of findings that follows the table, when distributions were skewed in their original format (as SOL and SE were, for example) I report differences in means as well as differences in median values.

Table 14: Significant findings for technology use and sleep variables, based on technology diary data

	Technology Use Yes/No	Computer Use Yes/No	Screen Use* Yes/No	Cell Phone Use Yes/No	Correlation with minutes of technology use
Lights Out (Bedtime)					Weeknight 1: negative correlation, $p=.022$
Sleep Onset Latency (SOL)		Sunday night: shorter sleep onset latency, $p=.010$	Sunday night: shorter sleep onset latency, $p=.003$		
Total Sleep Time (TST)				Sunday night: less sleep, $p=.015$	
Sleep Efficiency (SE)	Weeknight 1, Males: lower sleep efficiency, $p=.031$ Weeknight 2, Males: higher sleep efficiency, $p=.027$		Weeknight 1, Males,: lower sleep efficiency, $p=.001$		Weeknight 1, controlling for gender: negative correlation, $p=.033$

*Included computer, TV, or game system use

Many of the significant relationships detected were in the direction expected based on previous research. On Sunday night, teens who used cell phones ($N=7$) slept an average of 366 minutes vs. the non-cell phone users ($N=23$) average of 429 minutes, a difference of 1 hour and 3 minutes of total sleep time ($F(1,28)=6.776, p=.015$). On weeknight 1, **males** experienced changes in sleep efficiency (SE) related to overall technology use (F

(1,17) = 5.545, $p=.031$) and screen use ($F(1,17)=15.887$, $p=.001$) . Males who used technology (N=8) reported 89% SE (median 88.5%), while non-users (N=11) reported 95% SE (98% median). Males who used computers, TVs or game systems on weeknight 1 (N=5) reported 85% SE (84% median), while non-screen users (n=14) reported 95% SE (97% median). While all these sleep efficiency values may seem high, the 95% SE reported by non-technology users is more typical of adolescent values, with SE values in the 80's representing a drop compared to normal teen SE values (Carskadon et al., 1998). Also on weeknight 1, minutes of technology use (where technology-use minutes >1) were significantly negatively correlated with Lights out (Bedtime) ($Rho(17) = -.551$, $p=.022$) , and sleep efficiency, controlling for gender ($r(14) = -.535$, $p=.033$).

Some findings, especially for sleep onset latency (SOL), and in one case sleep efficiency, were in the opposite direction from expected. On Sunday night, computer users (N=6) took 4.5 minutes, on average (median 5 minutes), to fall asleep, compared with an average of 27 minutes (10 minutes median) for non-computer users (N=25), ($F(1,29)=7.558$, $p=.010$). Individuals who used all screens (computers, TVs and game systems, N=8) took 5 minutes on average (median 5 minutes) to fall asleep, compared with 29 minutes (median 10 minutes) for non-screen users (N=23) on Sunday night ($F(1,29)=10.418$, $p=.003$). The higher SOL values of 27 and 29 minutes approach the 30-minute SOL value suggestive of insomnia, if experienced consistently. In addition, on weeknight 2, technology using **males** (N=7) showed greater sleep efficiency, 97% mean

and median, compared with non-technology using males ($N=10$, 88% mean, 90% median), ($F(1,15)=5.961$, $p=.027$).

Today's "technology environment" definitely affects teen sleep. Teens use a variety of technologies, some almost constantly, to maintain communication with others and to access both information and entertainment resources. This type of technology use provides a real-world example of theoretical construct of flexible accumulation, where individuals, according to anthropologists Vuckovic and Nichter, feel "the need to rapidly retool and restructure in response to constant and immediate feedback" (1997 p. 1289). These authors apply flexible accumulation to pharmaceutical practice, explaining that modern medicines enable multi-tasking, letting an individual simultaneously work and care for her illness. This multi-tasking is key in the late modern economy, where many individuals perceive time as a scarce commodity, leaving them without the "time to be sick." For teenagers, time is also scarce, and my participants responded by multi-tasking – for example, working on homework, talking on the cell phone, and sending friends instant messages at the same time on a weeknight. This technological multi-tasking allowed teens to receive constant and immediate feedback about what friends were doing, thinking and feeling, as well as what a wider universe of unknown individuals found valuable (for example, what "internet users" as a group posted on Youtube). However, unlike the multi-tasking example of working and caring for an illness, it is not possible for teens to multi-tasking by combining sleep and any other activity. As a result, teens may stay up later, and when they do fall asleep they often keep their computer and cell

phone within arm's reach all night long, and wake up to respond when they hear the beep that tells them they have a new message. Many workers in the late modern economy focus on flexibility with regard to their work hours and their specific skills, and their teenage children emulate them by engaging in flexible (always-on) communication and learning not only school-based skills but also leisure time skills. This includes participating in extracurricular activities, engaging in social interactions, and becoming proficient with, and then using, new personal technology items, all of which have the potential to interfere with sleep. Until teens reach a point of information overload (which some teens are already showing signs of, with their refusal to be present on MySpace) or technology stops allowing real-time updates (which seems unlikely), the effects of technology use on sleep and other health behaviors (see Van den Bulck and Eggermont, 2006 for an exploration of the effect of technology use on meal skipping and fast eating) will remain a valuable area for further investigation.

CHAPTER 6: NORMAL – AND NORMALIZED - TEEN SLEEP

When examining the literature on “normal” teen sleep, the majority of published studies focus on how biological events of adolescence, such as puberty (Carskadon et al., 1993; Hagenauer et al., 2009; Knutson, 2005), and external factors, such as school start times (Lamkin-Carughi, 2007; Wolfson et al., 2007; Wrobel, 1999), affect adolescent sleep. Although these are critically important factors, these foci tend to compartmentalize adolescent lives. All adolescents go through puberty, and most transition to early school start times, often at the beginning of high school. But these changes occur in a larger context suggested in the previous chapters. This context includes cultural values espoused by school, family, and the media, and multiple demands on teen time, including homework, activities, family time and the lure of technology. Therefore, given this context, one of the key questions to be answered by this research was **“What constitutes "normal sleep" in this population of adolescents?”**

Exploring normal sleep in this population illuminates the intersection of *visceral embodiment*, which is the biological body’s contribution to sleep, as well as *pragmatic embodiment*, where teens seek to “sleep like a teenager.” As emphasized in Chapter 4, one of the ways teens gain information about sleep is through their own experience of sleeping for a short or long time. Therefore, their own *experiential embodiment* of adequate or inadequate sleep drives what they perceive as normal sleep – or at least normalized sleep for them as teenagers – enough sleep so that they are able to (mostly)

meet their academic, family and social obligations and do things they enjoy, but not enough that they feel completely rested. This perpetual tiredness opens the door for teens' *visceral embodiment* of sleep, where the body may take over and demand sleep when teens are *too* sleep deprived to continue to function. In this chapter, I explore high school as a site where inadequate teen sleep is normalized, and then describe what constitutes normal weekday and weekend sleep in this population of adolescents. I examine how adolescent participants in this study described physical, mental and emotional consequences of too little sleep, and explain how one of my key informants, 15-year-old Billie, viscerally embodied her inadequate sleep. After this exploration of experiential and visceral embodiment of inadequate sleep, I address potential coping behaviors of napping and adjusting sleep timing, beginning to answer the questions, **“What are specific ways in which adolescents cope with inadequate sleep? And do strategies vary with regard to household composition, gender, or ethnicity?”**

I then conclude by asking if “normal sleep” differs in this population between males and females, White and Hispanic teens, or adolescents engaged in varying levels of physical activity.

Normalized sleep

High school, as an institution, is about normalization – attending such an institution is part of the way that young people learn how to be functioning, productive, “normal” members of American society. Or, in some cases, they learn how to reject the project to make them into “normal” members of society. What surprised me about my research

experience in high school, however, was how much “how to sleep”, while not explicitly taught in the school, is a part of the high school experience. Teachers, administrators, and security personnel in the school aspire to normality, because deviations from normal generally make it harder to keep teens focused on the rules and achievement valued in the high school. Part of the “normal” day in high school, as I learned through my participant observation, almost always involves teens – and sometimes teachers - who are sleep-deprived.

One of the teachers (Ms. D) I worked closely with provided some shining examples of normalized sleep loss. I learned that Ms. D barely slept shortly after I met her, and I put the following in my notes:

Ms. D sleeps about 4 hours a night. In the spring, she plays professional women’s football - she played in high school. She says caffeine has no effect on her. Over the year I come to think she’s the easiest teacher I observe, because students frequently end up doing book or busywork in her class. I attribute it partly to the fact that she’s so sleep deprived. She lives alone, after a bad breakup with a female partner who was a PhD student. She goes out most nights and seems to be the “social director” of her group of friends - one night is for karaoke, others for other things.

Throughout the year, she made periodic comments about her own sleep deprivation, for example:

“Anybody else tired? I’ve got to start going to bed before 2:30 am.”

Ms. D says [to me] she only slept an hour last night due to karaoke, but she’s doing a pretty coherent conduction/convection lecture.

Her students also commented on her typically sleep-deprived state:

Student: “Which bellwork are we supposed to do, the board or the screen?”
Ms. D: “The one on the board is Mr. F’s, can’t you tell by the handwriting?”

Student: “I just thought you got a lot of sleep”

Female asking about spelling of “valence” “I’m sorry but I’m sleep-deprived.”

Male in the back “That’s no excuse, she (the teacher, Ms. D) barely sleeps at all.”

Beyond Ms. D’s classroom, I also heard comments about sleep around the school throughout the day.

Early in the morning:

Overheard walking across the mall, “I’m f-ing tired too and you don’t see me crying about it.”

[While sitting in the lobby of the science building on a cold morning] Group across lobby getting louder - coffee kicking in or just critical mass of friends. “You know when you’re tired and you try to open your eyes and you’re like ‘uh’ and you just want to cry because you’re so tired” (girl).

Mid-day

Talked to Ben, a key informant, at lunch, and he said Halo 3 is coming out tonight (at 12:01 am, his friend put in). He is planning to go get the game and stay up playing it tonight/tomorrow morning.

In Class

Talked with a few students in Mr. S’s class about what I do. One boy says if you sleep less, you eat more. Another boy asks me how many kids have fallen asleep in class today and I try to explain my study is more than sleeping in class. Another boy says he always sleeps in this class because it’s boring and his body tells him he’s tired. Later he passes me (moving to another seat - they have a sub so the class is kind of chaotic) and says, “going to sleep now, Miss.”

All of these conversations and overheard snippets reinforced to me that part of the “common experience” of high school at the close of the first decade of the 21st century is one of relative sleeplessness.

Descriptive sleep statistics

Weeknights/school nights

To reflect participant sleep most accurately, seven adolescents who had some problem with their weekday sleep data were removed from analysis. This occurred mainly for inaccurate reporting on Sunday night, which was supposed to count as a “weekday” night but often looked more like a weekend night with wake times reported in the 10 to 11 am range, instead of an earlier time that corresponded with a Monday morning school start time of 9 am. Other reductions in N resulted from missing data on one or more nights.

Table 15 reports results for total sleep time (TST), sleep quality and sleep onset latency (SOL), the time taken to fall asleep, across four weeknights.

Table 15: Total sleep time, sleep quality and sleep onset latency on weeknights

	Sample Size	Mean TST	Standard Deviation	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound)	Mean Sleep Onset Latency
Weeknight 1	43	426 minutes	82 minutes	3.26	20 minutes
Weeknight 2	43	438 minutes	58 minutes	3.33	23 minutes
Weeknight 3	41	444 minutes	63 minutes	3.24	21 minutes
Sunday night	37	418 minutes	81 minutes	3.19	28 minutes
Mean Weeknight	35	433 minutes 7 hours 13 minutes	42 minutes	3.26	25 minutes

For weeknights, it is clear that these teens are obtaining far less than 9.25 hours (9 hours and 15 minutes) per night of sleep. Instead, their mean sleep ranges from 6 hours and 58 minutes on Sunday nights, up to between 7 hours 7 minutes and 7 hours 24 minutes on a typical weeknight. On average, these teens are going to bed and turning out their lights around 10:25 pm and waking at 6:07 am, though they do not get out of bed until closer to 6:19 am. On weeknights, the mean SOL value is 25 minutes. This partially reflects that it takes a relatively long time for these teens to fall asleep, but the mean is also increased by extreme values, and some teens in my study took over two hours to fall asleep on weeknights. The median value for SOL across weeknights, by contrast, is 14 minutes. As expected, weekday wake times seem to be driven by school start times, with a mean school day wake of 6:07 AM. School start time Tuesday-Friday at the study school was 8 AM, with Monday start time delayed to 9 AM. However, parental work schedules were not likely to vary in this way, so Monday wake time for most teens did not vary from other days, with the exception of a few students who slept until 8:15 AM.

Family members definitely influenced the sleep of adolescents, especially on weeknights. This can be seen in **Table 16**, below, which details correlations (using Spearman's Rho, due to high skewness and kurtosis z-scores for some wake-time and bedtime distributions, especially mother's wake time and bedtime) between adolescent wake times and bedtimes with the wake and bed times of their family members.

Table 16: Correlations between teen and family member sleep timing: Spearman correlations for wake times and bedtimes

Significant correlations with:		Spearman's Rho, p-value
Adolescent wake time (adolescent n=43)	Older sister's wake time (older sister n=6)	Rho=0.841, p=.036
	Younger sister's wake time (younger sister n=14)	Rho= 0.742, p= .002
Adolescent bedtime (adolescent n=43)	Father's bedtime (father n=27)	Rho=0.541, p =.004

Although the effects of having an older or younger sibling on adolescent wake time and bedtime were not significant when examined using the Mann-Whitney U test, small variations in adolescent wake time and bedtime were seen. Specifically, teens who had an older sibling (n=13) got up 15 minutes later and went to bed 7 minutes later, on average, than their peers who did not have older siblings. Teens who had younger siblings (n=24) woke up 15 minutes earlier and went to bed 22 minutes earlier, on average, than their peers who did not have younger siblings. These sibling effects might be significant if examined in a larger sample.

Across families, some common threads regarding sleep and wake behaviors on the weekdays recurred in just about every interview. For example, all teens were woken in the morning by their alarm, a parent, or often both. Although mean rise time (when teens actually got out of bed) across all participants was almost 6:19 am, some teens got up much earlier, like Billie, a 15-year-old White female who played soccer for a club team.

On weekdays? [the alarm goes off at] 4:30, and my alarm clock is ten minutes fast, so 4:20, but then I actually get up at 4:30 when it goes off a second time, and then I get out of bed and stretch. Then I walk over to my light and turn it on then I straighten my hair or jump in the shower, depending on how I do my hair. Except if I don't do the shower, I can actually sleep in for five minutes. Right after I get out of the shower, then I grab money for the bus...and I normally get there till like, two minutes before the bus. [I get to the downtown transit center] at 6:21...when I'm meeting my boyfriend, I meet him on the other side and I walk around somewhere on E St. We time it. I end up meeting him at 6:45, it takes me that long, but I take my time on The Avenue, because the windows have reflections, and I can see what my hair looks like, or whatever, fix my makeup... we'll go to Starbuck's or hang out at the corner store and I'll have, maybe, a soda, a lot of the time, I get Squirt, I like Squirt, or a bag of Funyons, eat my Funyons, but I haven't been getting them lately. And then I end up heading over [to school] at around 7:40; sometimes I get here late, shame on me. I'm [just] across the street. (Billie, 15)

Bedtimes in this population were determined by a variety of factors, including parental rules and suggestions about sleep timing, homework, a variety of after-school activities (which related to how late a teen got home in the evenings), and various types of technology use. To better understand the relationship of parental rules to increasing (in some cases) homework loads associated with the transition to high school, I asked teens (n=41) “*Do your parents let you stay up to finish homework past your usual bedtime?*” Teens most often said yes, parents let them stay up if they said they were finishing homework (41.5%). Many teens also chose the response “I am in charge of when I go to bed, parents don't have much to do with it” (34%). Around 12% of parents encouraged teens to stay up to finish homework, while an equal percentage encouraged their sons and daughters to go to bed even when not all their work was completed.

Weekends

To reflect participant sleep most accurately, one adolescent who had a problem with her weekend sleep data was removed from analysis⁸. **Table 17**, below, reflects weekend TST, sleep quality and SOL.

Table 17: Total sleep time, sleep quality and sleep onset latency on weekends

	Sample Size	Mean Total Sleep Time	Standard Deviation	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound)	Mean Sleep Onset Latency
Friday Night	40	495 minutes	130 minutes	3.50	15 minutes
Saturday Night	43	521 minutes	127 minutes	3.61	20 minutes
Mean Weekend Night	40	508 minutes 8 hours 28 minutes	112 minutes	3.56	18 minutes

The mean value of sleep on Friday night was almost 8 hours and 15 minutes, while on Saturday it increased to 8 hours and 41 minutes. Therefore, even on weekend nights, at least half of the teens in this sample still were not obtaining enough sleep⁹, although by Saturday night, many were approaching the recommended sleep duration of 9 hours and 15 minutes. In a number of published studies, teens report sleeping an average of 9 hours or more on the weekends (Shinkoda et al., 2000; Wolfson and Carskadon, 1998). However, a few studies point to approximately 8.5 hours of sleep on the weekends for

⁸ This individual got up at 5 AM to watch a World Cup soccer match and then returned to bed afterward.

⁹ Looking at the median values (50th percentile), which might be a better measure on the weekend since mean values are more easily changed by extreme outliers, adolescents reported 7 hours and 59 minutes of sleep on Friday nights, while they slept somewhat more, 8 hours and 55 minutes, on Saturday nights.

teens (Carskadon et al., 1998; Wolfson et al., 2003). My finding of Saturday night as the night of longest sleep in this population is important, because it shows that some of these 9th graders may be able to catch up a little on lost sleep on this night. However, Saturday catch-up sleep may be fleeting as teens progress through high school. As these adolescents get older, this “catch-up time” will likely be converted from rest time into social time. High school freshman may be hanging out with friends, family, or going on group dates on Saturdays, and so they adjust to the sleep timing required by those activities. As teens move through high school, however, they often gain more freedom to go out Saturday night, and most start driving, so they have greater mobility. All of this impinges on sleep, potentially eroding weekend catch-up time.

Consistent with other adolescent studies, *most* adolescents in this sample do sleep longer on the weekends. Compared to weeknights, the time it takes teens to fall asleep (sleep onset latency) on weekends is shorter (mean 18 minutes, 7.5 minutes median). On average, these teens are going to bed around 11:05 pm and waking at 7:55 am on weekends, though they do not get out of bed until closer to 8:10 am. Although this seems very early, weekend realities for these teens include band competitions, soccer games, work (typically with family businesses), church, volunteer work, expectations from parents about chores and from younger siblings about playtime, and of course, the phenomenon of their body waking up on the weekends at the same time as they wake on the weekdays. David, a 15-year-old White male who runs cross country and track,

explains how his 9-year-old brother may cause him to wake earlier than planned on the weekend:

KMO: ...what are the weekends like? Do you get to sleep in a little bit?

David: Yeah, unless my brother comes in -- my little brother.

KMO: Mmm-hmm. Do you have your own room or do you share a room?

David: I have my own room but he comes in there and wakes me up. I don't know why...he gets up really early on weekends. He sleeps in on weekdays but then he gets up earlier, like, I don't know why.

Eric, a 14-year-old White male involved with the school marching band, describes his body waking him up on the weekend, "I go to sleep around 11, 12, and I wake up around 8 or 9, no, 9-10, I dunno why, I try to keep it as dark as possible, somehow my body just wakes up, [my] internal alarm clock goes off."

Reviewing data collected on teens' weekend activities, many study participants stressed weekend activities that required them to get up early in the morning, and talked less about activities that might keep them up at night, except for brief discussions of sleepovers, late-night gaming, and one teen who talked about going to an all-night skate at a roller-skating rink. I did not specifically ask about curfew or parental rules governing bedtimes on the weekends. Although teens did go out with friends and participate in social activities with friends and family, for many it seemed that weekends were a catch-up time, not only for sleep, but for resting more generally – getting up a little later, eating a leisurely breakfast, going online, seeing a movie with a friend – or responding to the particular circumstances of what that weekend day brought, because each weekend varied.

Summer nights

A sub-sample of students kept summer sleep data. These adolescents represent a convenience sample rather than a randomized selection from the entire sample. No adolescents were removed from analysis in the summer sub-sample. Mean TST, sleep quality and SOL values are presented in **Table 18**.

Table 18: Total sleep time, sleep quality and sleep onset latency on summer nights

	Sample Size	Mean Total Sleep Time	Standard Deviation	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound)	Mean Sleep Onset Latency
Summer Night 1	20	498 minutes	131 minutes	3.75	37 minutes
Summer Night 2	19	474 minutes	154 minutes	3.30	37 minutes
Summer Night 3	20	498 minutes	108 minutes	3.90	22 minutes
Mean Summer Night	19	490 minutes 8 hours 10 minutes	131 minutes	3.65	32 minutes

Though one might envision summer as a time of “sleeping all day,” the mean value for summertime sleep for the twenty adolescents who kept summer data fell in a narrow range between 7 hour 54 minutes and 8 hours 18 minutes. This is between the mean for weeknight sleep (7 hours 13 minutes) and the mean for weekend sleep (8 hours 28 minutes) collected during the school year.

Ana, a 15-year-old Hispanic female who was involved in many activities from sports to theater, talked nostalgically in her interview about sleep in the summertime:

Ana: Like, in the summer, my body gets programmed to go to bed at 3 in the morning, or 4 in the morning, because I know that I'll have all day to sleep so I know that I'll get my sleep back and, on days like Wednesdays and Mondays, for Dance, during the summer, I go to bed at 4 and I still have all that time to sleep and get my sleep back 'cause then I wake up around probably 12 in the afternoon or 1 in the afternoon and...like, I have two hours to get ready for Dance. In the summer, it's completely different but at the beginning of summer, my body's still programmed to go to bed early so it's kind of hard for me to get back in the ... (trails off)

KMO: And then when you get back to school in the fall it's, like, total stress, huh?

Ana: Yeah, it's very hard to get back from summer, very hard! I mean, it takes time but it still happens, like, it has to happen. 'Cause I remember the first week of school... 'cause I was really scared and everything, and then, like, I didn't have problems waking up the first week but then once I got the hang of high school, I started going back and reliving my summer, wanting to stay up, stay up all night, go to bed, wake up, like, at 12 or 1. The latest that I slept in was 'til 4 in the afternoon because I stayed up all night until, 'til like, 6 and then I woke up at 4. But I still got my sleep back, I still got my sleep time back even though it was during the day. I like it.

KMO: What do your parents say in the summer if -- when you're awake all night and asleep all day?

Ana: They get -- They get mad because sometimes I'll do it every day for about a week and then, like, it's -- it's kind of a everyday thing in the summer because they understand how I don't have school and then they go, "Well, you can still get up and do stuff around the house" 'cause I'll just sit there, be a couch potato, like, most of my whole summer unless if my friends, like, I'll spend the night at friends' houses and everything but -- They say, yeah, "You're just sleeping at the computer or at a friend's house." Yeah, I get a lot from them and they get mad sometimes but then they understand how I have to go a whole nine months of school.

Without school to set their schedules, during the summer adolescents drifted toward a schedule that better fit their biological phase-delay preference – going to bed later (mean 12:46 am), and getting up later (mean 9:25 am for wake). For many, this meant postponing bedtime until after midnight (52.6% of participants), and in some cases, staying up until 3 am or later (15.8% of participants). Wake times were also pushed correspondingly later. While mean “out of bed” time was 9:37 am, 52.6% rose at 10 am

or later, and 15.8% got out of bed at 11 am or later. Teens were largely able to do this because they had few set obligations over the summer. While 7 of 20 teens did attend summer school (which concluded before I collected my summer data), only four reported holding jobs – one full-time, and three part-time. This low employment rate was to be expected, as teens younger than 16 have many limitations on work hours and timing in Arizona. The employed adolescents typically worked for businesses run by their families. More often, teens reported that they engaged in “flex-time” activities like helping to care for siblings or practicing/staying in shape for sports, music or other activities over the summer, and 95% marked the questionnaire option for “I spent time doing what I wanted in the summer.”

Why does it matter? Teen perspectives on the effects of too little sleep

While designing the study to capture specific pieces of information about sleep for each of my participants, I also kept in mind the larger picture. Although descriptive statistics about adolescent sleep were my starting point, I also wanted to compare this sleep data to teen perceptions of sleep, and ask how teens keep going, when many of them face long-term partial sleep deprivation. Two of my specific research questions address this desire to capture the larger picture. The first, “**How do adolescents in this population perceive their own sleep?**” has largely been addressed in Chapters 4 and 5. In this chapter, I examine the adolescent experience of sleeping too little. I asked them specifically about their physical, mental and emotional experience of sleeping too little, seeking to capture teens’ experiential embodiment of sleep (Meadows, 2005). I also

begin to address the questions, “**What are specific ways in which adolescents cope with inadequate sleep? And do strategies vary with regard to household composition, gender, or ethnicity?**” in this chapter by exploring the potential coping behaviors of napping and adjusting sleep timing. I continue to address these questions in Chapter 7 by considering coping behaviors related to food intake and activity levels.

Sally, a 14-year-old White female who plays volleyball for the school team, speaks more articulately than many teens about her experiential embodiment of inadequate sleep, and her responses are echoed by a number of other teen study participants.

KMO: How much sleep do you think is too little sleep for you?

Sally: Too little for me, well, a couple of times I’ve gotten away with like, five hours of sleep, but usually I can’t do that for more than one or two days. I need probably at least six.

KMO: When you sleep too little, when you get like five or six hours, what do you feel like, physically, mentally?

Sally: During the day, I feel kind of sluggish, in my limbs at least, and then in class, it’s kind of like, you think, I can sleep, I’ll be fine. And the next thing you know, you’re looking up from a sitting position, and your teacher is talking about something you’ve never heard of, so you have to kind of back track and ask your friends for notes and put out a little effort on your part. It’s a pain in the butt.

KMO: Do you feel different, emotionally, when you’re operating on too little sleep?

Sally: Usually, it’s not so much that I’m more emotional, it’s that I’m not emotional at all. I’m just going through the day, on autopilot. Like, if I was to walk to a class right now, I would probably find myself in the wrong place if I were to think about it, because I’m so used to just going through the motions.

Like Sally, nineteen other adolescents (out of N=49) find 5-6 hours to be their sleep “minimum.” Many talked about how they embody too little sleep - the sluggishness they feel in their bodies and limbs, saying they feel weak, drained, unable to lift things, or like they are going to “fall down and fall asleep” (Mateo, 14-year-old Hispanic golfer).

Angela, a 14-year-old Hispanic female active in orchestra and softball, among many other activities, says her “body is harder to move around,” while Annie, a 15-year-old White soccer player said “I feel like I’m on some kind of antibiotic, where you cannot move and I’m just drowsy...” One of the most colorful descriptions of this phenomenon was from Lilly, a 15-year-old White female who liked to write and draw, who simply said it’s like “somebody put bricks on me.” A few students mentioned that one way to combat this sluggish feeling was to move around, although this behavior was often frowned upon during class as it was seen as disruptive by teachers and sometimes other students.

Males, especially, tended to emphasize the physical limitations associated with sleep deprivation. Their bodies couldn’t quite do the “normal” things expected of them...not that they didn’t try. Patrick, a 14-year-old White skateboarder, describes skateboarding on too little sleep:

KMO: How much sleep do you think is too little sleep for you?

Patrick: Six hours.

KMO: So, what happens when you get that little sleep? How does it feel?

Patrick: Well, that’s what usually happens when I go to peoples’ houses at night and I’m, like, I just wake up and I’m like, “OK” and then I just try to do whatever I do normally.

KMO: But you feel, like, just more tired and more out of it?

Patrick: Yeah and I’m worse at skateboarding...I’m usually more like, [I] take more risks when I’m tired, too...or, like, you’ll try to, like, do something crazy...and then if it’s really crazy, I’ll, like, try that sometimes, but I usually – it doesn’t work out.

KMO: Do you hurt yourself?

Patrick: Yeah. I’ve cut, like, three tendons here, or, like, right below it... it cut all the skin but it didn’t actually cut the Achilles tendon – so I was lucky for that but I couldn’t skateboard and I still have a scar after, like, three months.

Sally's description of going through the day "on autopilot" also resonated with many teens. They variously described themselves on the day after too little sleep as "out of it" (Patrick), "fuzzy" (Lucinda, a 14-year-old White female who participates in dance and the local teen newspaper) and "like a zombie – foggy and not totally there" (Jason, a 15-year-old White male who plays in the orchestra and runs track). They also notice the ill effects of too little sleep on their classroom participation. In addition to the description provided by Sally (and others) of actually falling asleep in class, those who stay awake say they feel slow, especially that their brain processing is slower, and they find it hard to concentrate and pay attention. Some state flat out that on too little sleep, they just "don't care about anything" (Christina, a 14-year-old White female active in choir and drama and Mark, a 15-year-old Hispanic male not involved in activities). Roberta, a 15-year-old Hispanic female involved in soccer and Folklorico dancing, among many other activities, and who was very sleep-deprived at the time of her interview, summed it up, "Your brain on too little sleep [is] easily distracted, goes off to different topics, is talkative" but then "the teacher talks and asks you something and it's difficult to respond."

Emotionally, teens report feeling cranky, grumpy, sad and more easily irritated when they don't get enough sleep. They feel their patience wears thin, and they're more likely to get mad or snap at friends. Some teens feel that they just want to avoid others when they haven't had enough sleep, but others some students say that hanging out with friends when they are sleep-deprived is a strategy that makes them feel better.

In interviews, a few students specifically said that sleeping too little felt “normal” for them. For example, Victor, a 14-year-old who played basketball, said that after three or four hours of sleep, the next day, “It’s kind of normal.” He even framed his tiredness in a positive light, saying after a night of too little sleep, “...like I’m tired, but it’s sort of like one of those...like I just got done exercising or something.” Although he was one of the few to express his tiredness in this way (most others framed it more negatively), the discussion of too much sleep being lazy in Chapter 4 combines with Victor’s comments to support an idea of adequate sleep as “optional” – the consequence of too little sleep might be that you are tired, but tired is the “new normal.”

Sometimes teens were so tired that their bodies demanded that they go to sleep, preferably immediately. In this way, teens viscerally embodied their inadequate sleep; although they resisted for a while, ultimately their bodies shut down. Billie, a 15-year-old White female soccer player who was one of my key informants, along with her boyfriend Ben, relayed the following story of how she fell asleep unexpectedly one evening:

Billie: One time, it was really weird, I got a half an hour of sleep, and then I went to a soccer game, and I went to Ben’s house, I was at his house at 7 o’clock at night, sitting on the counter, and I fell asleep on the counter. And they made fun of me, and took pictures, and tried to feed me....

KMO: While you were sleeping?

Billie: Yes! I was on the counter leaning toward the fridge, I woke up from his dad laughing.

Coping behaviors to deal with sleep loss

To begin to answer the second question about what teens do to cope with inadequate sleep, I asked teens directly about this topic. A question on my fall data questionnaire (when teens had entered their sophomore year of high school) asked adolescents if they thought it was possible to catch up on lost sleep, and if so, how they could do it. **Table 19, below** shows their responses, in order of popularity. There were no differences in responses based on ethnicity, although some differences were evident by gender (see column in Table 19), although the small numbers precluded a “significant difference” finding in Chi-square comparisons. Household composition, looking at whether a teen lived with both parents, one parent (with or without a stepparent) or in another type of situation, only affected one response to “How can you catch up on sleep” – napping in class. Although only 4 individuals mentioned this way to “catch up,” all lived with only one parent (although 1 of the 4 did also have a stepparent in the house). This was significant by chi-square, $\chi^2(2) = 7.184$, $p = 0.028$.

Table 19: How teens say they can catch up on lost sleep

“Can you catch up on sleep you miss? If so, how?”	Number with this response Notes	Gender difference?
No	18 Includes four who say they get enough sleep, one who explained “no, my life is really crazy” and another who said “no, so many things to do when I wake up – chores”	Among those who said they got enough sleep: $\frac{3}{4}$ are female
Nap	16 Includes 4 who specify that they nap in class	Among those who nap in class: $\frac{3}{4}$ are male
Catch up on weekends, breaks	8 Includes one who specifies “crashing for extreme hours”	$\frac{3}{4}$ are female
Go to bed earlier	4	$\frac{3}{4}$ are female
Sleep in later the next day	2	
Sleep longer the next night	2	

A surprisingly large number of teens responded “No,” they could not catch up on lost sleep although only a few specifically cited their busy lives as the reason that sleep could not be made up. More likely, the adolescents who say sleep cannot be made up have probably had the experience of “sleeping too much” and finding that it did not make them feel any better because it did not erase their sleep debt, it just reminded them how much more sleep they really needed! When I asked in interviews if it was possible to sleep too much, approximately 50% of the teens said that it was, and went on to describe times when they had slept a lot on weekends, or over breaks, and woken up only to find themselves still tired – perhaps even more tired than they would have been had they slept too little. By looking at the sleep diary data presented above, it is clear that many teens do sleep in on the weekend in an effort to make up sleep, although they may not be doing

this consciously. Given the variability of weekend sleep, they may not be “catching up” so much as “not accruing sleep loss at the same high rate.” Below, I will present data from this study regarding students’ napping behavior, and their efforts to go to sleep longer following a night of poor sleep.

To make these comparisons, I calculated mean sleep durations for teens on weekdays and weekends, along with a standard deviation for each of these values. I then examined days when teens slept one standard deviation *more* than average the night before, and when teens slept one standard deviation *less* than average the night before. The relevant means, standard deviations, and number of teens displaying “short” and “long” sleep are listed in **Table 20**, below.

Table 20: Mean and standard deviation for weekday and weeknight sleep, and the number of teens displaying short and long sleep on each night

Day	Mean sleep time	Standard deviation	Cutoff for short sleep/ Cutoff for long sleep	Number of “short sleep” teens	Number of “long sleep” teens
Weeknights					
Weeknight 1	433 (7 hrs 13 mins)	42	391 (6 hrs 31 mins) 475 (7 hrs 55 mins)	8	13
Weeknight 2	433	42	391 / 475	10	14
Weeknight 3	433	42	391 / 475	7	11
Sunday night	433	42	391 / 475	11	9
Weekend nights					
Friday night	508 (8 hrs 28 mins)	112	396 (6 hrs 36 mins) 620 (10 hrs 20 mins)	10	8
Saturday night	508	112	396 / 620	7	6

Napping

To analyze napping, I looked at overall frequency of napping on weekdays and weekends and then compared teens within categories (endorsed naps, endorsed napping in class, gender, ethnicity, household composition) who reported any nap minutes to those who reported no nap minutes using Chi-square. Overall, 27% of adolescents reported napping on any weekday (12/44). Naps ranged from 10 minutes to 300 minutes during the week. Most teens only napped on one weekday, but four students, two Hispanic and two African-American, two male and two female, reported napping on more than one weekday. Teens who endorsed napping in class as a way to make up lost sleep were significantly more likely to report weekday nap minutes (N=3 who reported nap minutes vs. N=1 who did not ($\chi^2(1) = 6.000, p = .014$)). This relationship was not significant for teens who responded that napping in general was a good way to catch up on lost sleep (N=5 who endorsed napping but reported no nap minutes, compared with N=4 who endorsed and reported weekday napping ($\chi^2(1) = 1.662, p = .197$)). Mean weekday nap minutes did not differ significantly by gender or household composition, using the non-parametric Kruskal-Wallis test due to high skewness and kurtosis Z-scores for mean weekday nap minutes. Mean weekday nap minutes did differ by ethnicity, however, $\chi^2(2) = 9.139, p = .010$. Further analysis of differences between groups using the Mann-Whitney U test showed that White teens (N=18, mean weekdays nap minutes=9) and “Other” ethnicity teens (N=5, mean weekday nap minutes=43) had significantly different numbers of nap minutes, $U(1) = 17.000, Z = -2.699, p = .007$. Hispanic teens (N=20, mean weekday nap minutes=6) and Other teens also had significantly different numbers

of nap minutes, $U(1) = 17.500$, $Z = -2.569$, $p = .010$, although White and Hispanic teens did not differ significantly from one another, $U(1) = 172.000$, $Z = -.717$, $p = .474$.

On weekends, 14% reported napping at all (6/44), with naps ranging from 49 minutes to 120 minutes in length. Among teens who mentioned napping as a way to cope with lost sleep, however, individuals who endorsed napping in general were more likely to report nap minutes on the weekend ($N = 4$ out of 6 for “napping helps with sleep loss” group vs. $N = 8$ out of 34 for no such endorsement, $\chi^2(1) = 4.519$, $p = .034$). On weekends, napping did not differ by ethnicity or household composition. Although five weekend nappers were female and only one was male, this was not a statistically significant difference.

Examining total sleep time *plus* naps taken on the same day for all adolescents on four weeknights and two weekend nights, teens who napped slept more on *one* weeknight and on *Saturday* night, although napper and non-napper total sleep time were only significantly different, as assessed by the Mann-Whitney U-test, on the weeknight ($U = (1) 35.000$, $Z = -2.101$, $p = .036$).

After looking at the whole sample’s napping behavior, I compared teens who were classified as “short” and “long” sleepers on a given night, based on the criteria of standard deviation from the mean listed in **Table 20**. Overall, differences between short and long sleepers with regard to napping behavior were not significant, both measuring the presence or absence of naps between groups using chi-square comparisons, and

comparing nap durations using the Kruskal-Wallis and Mann-Whitney U tests (due to the non-normality of nap distributions). Small numbers of nappers no doubt contributed to these non-significant findings. Among sixteen weeknight short sleepers, three took naps (19%) while among 27 weeknight long sleepers, two took naps (7%). On weekends, short sleepers were *less* likely to take naps than their long-sleeping counterparts. On two weekend days, among 18 short sleepers, none took naps, while among 15 long sleepers, one reported a nap (7%).

In this population of teens, napping *may* be used to cope with inadequate sleep on weekdays, although a larger sample of napping teens would be important to strengthen this finding. However, it seems that weekend naps are not used by short-sleeping teens in this population to augment their sleep. This may be because this is a true finding; alternatively, this finding may be the result of the under-reporting of naps in this teen population. Naps may simply be forgotten when an adolescent completes his or her sleep diary. A more interesting possibility, requiring further research, is that naps are deliberately minimized by teens (either the actual taking of naps or their reporting) because of a negative cultural view of napping in the United States. Although they are tired, teens may feel especially unable to nap on the weekend. They may be engaged in outside-of-school “achievement” activities like sports or music groups, they may have family obligations or they may find that weekends are the best time to spend with friends, and napping gets in the way of these achievement-focused and social activities.

Catching up on sleep the next night

Eric: I think less than 5 hours is pretty bad

KMO: have you ever gotten that?

Eric: Yeah, usually at a sleepover

KMO: what happens the next day?

Eric: I'm just kinda slumming around, not doing anything, and I'll go to sleep earlier that day.

Like Eric, a 14-year-old White male who played in the marching band, some adolescents were able to cope with inadequate sleep by extending their sleep time the next night.

Table 21, below, details the percentage of teens reporting longer sleep on the night after “short sleep” (approximately 6.5 hours or less). Reports of sleeping longer after a night of short sleep did not vary significantly by gender, ethnicity or household composition.

Table 21: Percentage of teens experiencing longer sleep times on nights after a night of “short sleep”

Had “short sleep” on:	Sample size	Percentage of teens who had “short sleep” the next night	Percentage of teens who had “medium sleep” the next night	Percentage of teens who had “long sleep” the next night
Weeknight 1	8	37.5%	37.5%	25%
Weeknight 2	9	55.6%	33.3%	11.1%
Weeknight Mean		46.6%	35.4%	18%
Friday Night	10	50%	30%	20%
Saturday Night	6	16.7%	50%	33.3%
Weekend Mean		33.4%	40%	26.6%

On the night after “short sleep,” less than 25% of teens on weeknights and less than 33% of teens on weekends were able to extend their sleep to achieve “long sleep” (nearly 8 hours on a weeknight or more than 10 hours on a weekend night). A relatively large percentage of teens (up to 56% on weeknights and up to 50% on weekend nights)

maintained their short-sleeping habits on a subsequent night. This is alarming, and points to the usefulness of tracking teen sleep for multiple, consecutive nights. Although in this research I am able only to look at two weeknights (which in most cases are Monday and Tuesday night) and two weekend nights, future research that included additional consecutive nights, especially nights later in the week, when teens will have been accruing sleep debt for several more days, would be very valuable to provide additional insight on teen resilience and vulnerability with regard to sleep.

Sleep differences by ethnicity, gender and activity level

Having explored teen sleep both from teen perspectives and by looking at their actual sleep data, an additional question is whether adolescent sleep varies by ethnicity or gender. In interviews, all study participants express similar experiential embodiment related to getting too little sleep, and most give similar answers about how they might be able to cope with sleep loss. The coping behaviors of napping and adjusting sleep timing, discussed above, also do not seem to vary by gender or ethnicity, although sample sizes are too small to make a definitive statement. In response to specific questions about gender differences in sleep, teens in this sample postulate that girls sleep less than boys, as seen in Chapter 5. But are there measurable differences in this population regarding how much, or how well, teens of different ethnicities and genders sleep?

I hypothesize that some small ethnic differences in sleep duration may appear between White and Hispanic teens, although comparatively few studies have addressed effects of

Hispanic ethnicity on sleep. More commonly (though still in only a small percentage of total sleep studies) researchers note differences between Euro-American/White participants and African-American/Black participants, where African-Americans sleep more poorly (Hughes et al., 2007; Jean-Louis et al., 2001; Krueger and Friedman, 2009; Stepnowsky et al., 2003). In young people, Hicks and colleagues found a small ethnic difference in sleep duration between Euro-American and Hispanic university students in California, with the former obtaining slightly more sleep than the latter (Hicks et al., 1999). Even with the same principal investigator, however, studies may present a contradictory picture of sleep in Mexican-American youth. Two studies by Roberts and colleagues (2004; 2000) found higher rates of insomnia among Mexican-American adolescents in Houston, while a third study by the same group found no ethnic differences between Hispanic and White teens in Southern Texas, closer to the Mexican border (Roberts et al., 2006).

Ethnicity

Overall, there were almost no significant differences between sleep variables for White and Hispanic teens (See **Table 22** below). On both weekdays and weekends, White teens typically had slightly higher total sleep time and rated their sleep as slightly higher-quality, though these differences were not significant. To examine sleep onset latency, I transformed the variable by taking the log of the SOL value +1, to avoid zero values. Hispanic teens showed a seemingly large, but only marginally significant as calculated by one-way analysis of variance (ANOVA), mean difference in weeknight sleep onset latency (time taken to fall asleep, $F(1,29)= 3.371, p=.077$). On weekends, Hispanic teens

slept for nearly 1 hour less than White teens on Saturday night, which represented the biggest “catch-up sleep” night in this population. However, none of the overall weekend variables showed significant differences between White and Hispanic teens, indicating that Friday night sleep between White and Hispanic teens was very similar. From talking with Hispanic teens, it is possible that family parties extending late into the night on Saturday, sports games, church attendance, or part-time weekend work with family members led to reduced sleep for Hispanic teens on Saturday night. This difference would benefit from further anthropological research, however, including detailed research at the household level to discern ethnic differences in sleep patterns.

Table 22: Differences in total sleep time, sleep quality and sleep onset latency between White and Hispanic adolescents

	Sample Size White Hispanic	Mean TST White Hispanic	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound) White Hispanic	Mean Sleep Onset Latency White Hispanic
Mean Weeknight	18 14	440 minutes 425 minutes	3.39 3.36	16 minutes 41 minutes*
Mean Weekend Night	21 14	520 minutes 483 minutes	3.62 3.39	11 minutes 26 minutes

* Marginally significant difference by one-way ANOVA, $p=.077$.

Gender

Beyond ethnicity, additional literature suggests that my data may show small gender differences, especially between male and female wake time, with females waking earlier on school mornings (Lee et al., 1999). For males and females in this sample, however, there were few differences in mean values for total sleep time, sleep quality and sleep

onset latency (See **Table 23** below). Males reported longer total sleep time and high sleep quality on weekdays, while females reported longer total sleep time on weekends but approximately the same sleep quality as they reported on weekdays. Although literature has indicated that females rise earlier than males on weeknights (Lee et al., 1999), in this sample, the difference was not statistically significant. Only weeknight sleep quality showed a significant difference between male and female adolescents ($F(1,33) 8.094$, $p=.008$), using the parametric one-way analysis of variance (ANOVA) procedure because both male and female sleep quality distributions met the criteria for normality.

Table 23: Differences in total sleep time, sleep quality, sleep onset latency and rise time between male and female adolescents

	Sample Size Male Female	Mean TST Male Female	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound) Male Female	Mean Sleep Onset Latency Male Female	Mean Out of Bed Time Male Female
Mean Weeknight	16 18	439 minutes 427 minutes	3.56 3.12*	17 minutes 33 minutes	6:29 am 6:15 am
Mean Weekend Night	20 20	495 minutes 520 minutes	3.71 3.43	11 minutes 25 minutes	8:20 am 8:02 am

* Significant difference by one-way ANOVA, $p=.008$

Activity Level

Although I initially sampled on activity level, I found as I explored the activity data that these student self-reports of activity were not matching very well with the activity teens reported on their daily activity diaries. As described in Chapter 3, to investigate activity in a more nuanced way, I re-calculated activity levels based on actual activity engaged in

by teens on weekdays and weekends. I hypothesize that small differences will be apparent between more active and less active teens, with more active teens potentially showing better sleep quality and shorter sleep onset latency, as a study comparing adolescent athletes and low-activity controls recently demonstrated (Brand et al., 2010).

On weeknights, total sleep time, sleep quality ratings and sleep onset latency differ across groups (See **Table 24** below), with high-activity teens, at least on weeknights, showing differences in sleep quality (higher) and sleep onset latency (lower) in the directions predicted by recent literature (Brand et al., 2010). However only total sleep time differs significantly across groups by one-way ANOVA ($F(2,33) = 3.856, p = .031$). Further t-test analysis reveals that the main source of difference is between low and medium activity teens. The differences between medium and high activity teens, and low and high activity teens, are not significant at the .05 level. On weekends, medium-activity teens show the same pattern as weekdays, sleeping less and rating their sleep more poorly than either high or low activity teens, with SOL falling between their high and low activity peers, but none of these differences are significant.

Table 24: Difference in total sleep time, sleep quality and sleep onset latency across activity levels

	Sample Size High <i>Medium</i> Low	Mean TST High <i>Medium</i> Low	Sleep Quality (1 to 5 scale, 1=very restless and 5=very sound) High <i>Medium</i> Low	Mean Sleep Onset Latency High <i>Medium</i> Low
Mean Weeknight	8 <i>15</i> 13	432 minutes <i>412minutes</i> 453 minutes*	3.59 <i>3.20</i> 3.31	20 minutes <i>24 minutes</i> 30 minutes
Mean Weekend Night	13 <i>15</i> 13	516 minutes <i>471 minutes</i> 555 minutes	3.65 <i>3.40</i> 3.68	13 minutes <i>15 minutes</i> 22 minutes

*Significantly different across groups by one-way ANOVA, $p=.031$.

Conclusion

Looking across the week, these adolescents sleep the most on Saturday nights (mean 8 hours 41 minutes), then Friday nights (mean 8 hours 15 minutes). Their weeknight means all fall below 7 hours 24 minutes, with Sunday nights showing up as the time of least sleep for these teens (mean 6 hours and 58 minutes). The biggest problem for the sleep of these adolescents, beyond their habitually inadequate sleep, is the *mean* Saturday night/Sunday night disparity of 1 hour and 43 minutes. These teens are starting off their week with their bodies thrown out of whack, the equivalent of crossing almost two time zones every Sunday before starting the school week.

Teens perceive many negative effects of sleep loss, including physical, mental and emotional consequences. Even if they manage to resist sleep during class, their mental

processing and reactions to classroom activities are not what they might be with adequate sleep. In response to inadequate sleep, some teens get to a point of such tiredness that their body demands an immediate shutdown, as illustrated by Billie above. Although their sleep may be limited by biological changes set in motion by puberty, and external factors such as school start times, the reality for these teens is that those factors seem immutable. Adolescents know they are tired, and getting more sleep would fix that problem. They often see too many reasons to stay awake, however, and their biological phase-delay preference reinforces this desire to stay up. In addition, these teens attend a large public high school where sleep deprivation is highly normalized for students and for a sub-set of teachers, and this affects their perception of how much sleep is enough for them, convincing them that it's part of being a teenager to feel – and say – “I'm so tired.”

Although this study only shows small sleep differences across the three domains of ethnicity, gender and activity level, the differences that do exist are likely to be the results of a complex interplay among biological, cultural and environmental differences.

Biological differences may be seen especially in sleep differences shown across physical activity levels, while cultural differences may be seen in all three domains, as messages about sleep and sleep behavior modeled for teens are filtered through lenses of ethnicity, gender and activity level. Environmental differences play a role too, as ethnicity may serve as a proxy for socio-economic status, leading to different household and neighborhood factors (Hale and Do, 2007; Hill et al., 2009) that affect sleep.

While coping behaviors such as napping and altering sleep timing to catch up on sleep the next night seem only mildly effective, at best, for these teens, this may be the result of under-reporting (especially of naps) and /or realities associated with multiple demands placed on teens on both weekdays and weekends that do not allow them to follow up a night of short sleep with a catch-up night. In the next chapter I will continue to answer the question of how teens may change their behavior to cope with sleep loss by examining food intake, especially total caloric intake, fat intake, and caffeine intake, and durations of participation in physical activity in relation to sleep.

CHAPTER 7: COPING WITH INADEQUATE SLEEP: FOOD INTAKE AND ACTIVITY LEVELS

Methods and analysis review

As discussed in Chapter 3, to collect information on sleep and food intake, study participants completed up to **three** 3-day prospective diaries over the course of the data-collection period. Participants who stayed in the study for its entire duration (November 2006 to November 2007) generally kept 6 days of diaries, three days in the winter/early spring of 2007 following their enrollment into the study, and three days in the fall of 2007. A subset of participants who were available over the summer kept three summer diary days as well, bringing their total diary-days to nine per participant. See **Table 25**, below, for more detail on how many participants provided each number of food-diary days.

Table 25: Breakdown of food-diary days

Number of Food- Days Collected	Number of Participants	Percentage of Participants	Weekday Food-Days	Weekend Food-Days	Summer Food-Days	Total Food-Days
Three	6	12%	18			18
Six	24	48%	96	48		144
Nine	20	40%	80	40	60	180
TOTAL	50	100%	194	88	60	342
After exclusion of problem food-days *			178	79	60	317

* Criteria for food-day exclusion detailed below.

Sugar and caffeine intake were the focus on the “Coke Candy and Cellphone” (CCC) diary introduced in Chapter 3. As mentioned there, although teens sometimes did not record caffeinated beverages (or indeed, any beverages) as part of the food diary, they often recorded them on the CCC diary. Using a combination of the food and CCC diaries, I entered foods and beverages containing sugar and caffeine into ESHA Food Processor SQL, version 10.0. This enabled a calculation for each adolescent of the grams of sugar and the milligrams of caffeine they consumed each day they completed a diary.

By engaging in follow-up interviews with teens (detailed in Ch 3) when they handed me the packet containing their sleep, food and activity diaries, I was able to capture better detail about foods eaten, portion sizes, and days that were atypical (i.e., making notes about participant illness or other unusual circumstances that could later be attached to the food-day in the database and used to exclude that day from data analysis). Before any food-days were excluded, I had 342 analyzable food-days. Criteria for exclusion of a food-day included:

1. Participant was sick that day and reported not eating a normal diet.
2. Participant substituted another day for the requested food-day (for example, a Saturday when the participant reported eating a school lunch).
3. Participant did not report consecutive nights and days for sleep and food diaries (so Sleep Night 0 may or may not have occurred just prior to Food Day 1).
4. Participant specifically stated that some outside influence prohibited him/her from eating a normal diet on that day, including being away from home and not having

money to buy food, or being involved in an all-day event where only limited amounts of food were available.

Hypotheses about interactions among sleep timing, food intake and activity

In this chapter I will address the question, “**What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?**”

Recent literature suggests a link between short sleep and increased food intake, especially energy-dense foods such as fast food and sweets (Westerlund et al., 2009) and those containing more fat (Shi et al., 2008) in children and adults. Next-day physical activity in adolescents also seems to be affected by disrupted sleep the night before (Gupta et al., 2002). Literature also suggests a robust link between body mass index (BMI) and short sleep (Chaput and Tremblay, 2007; Knutson and Lauderdale, 2007). However, as this BMI-sleep connection falls outside of my dissertation analysis, details on the BMI-sleep relationship in this sample may be found in **Appendix B**. My specific hypotheses about sleep, food intake, and activity based on literature reviewed in Chapter 2, are:

- *If teens get less sleep (measured by TST), they will increase their total caloric intake, their caffeine intake, and their fat intake the following day.*
- *If teen sleep is more disrupted (measured by wake after sleep onset (WASO)), they will decrease their physical activity the following day.*

Teen comments on the sleep-food relationship

As I examined the relationship between sleep and food intake, I sought to explore adolescent conceptualizations of the difference or similarity between “sleep energy” and “food energy.” It might have been my wording, or simply that teens were unfamiliar with thinking about how sleep and food might differentially affect them, but most had difficulty answering the question. The most common response was that sleep gave them more long-term energy, while whatever they got from food intake was more short-term. Patrick, a 14-year-old White male skateboarder summed it up, “Because well, I think they’re different because whenever I’m skateboarding, after I just wake up, I have a lot of energy but, like, when I just eat food, I get energy [but] it doesn’t give me as much energy as it would if I slept a lot.”

Some teens also pointed out that, in their experience, “regular” food didn’t do a lot for them in terms of alertness, and in fact sometimes made them more tired, as Lucas, a 15-year-old Native American male skateboarder, points out. “Well, food can sometimes gives you an energy boost, but other times it can make you real tired too, say you’re real tired and you get done eatin’ a good meal and you get real tired.” Many teens only noticed a difference in their energy levels after consuming foods high in sugar and/or caffeine, as explained by Mark, a 15-year-old Hispanic male who did not participate in activities:

Mark: Like, when you fall asleep and you wake up the next morning, everything's fine, you're not tired in the morning, but when you need food, it doesn't really do anything [for how awake you are].

KMO: Not even for a little while?

Mark: Nuh-uh, unless it's something like a Red Bull.

Mike, a 14-year-old White male mountain-biker, explained why he thought sleep and food energy might be similar, citing the fact that when teachers told students to be well-prepared for the AIMS test (a statewide standardized exam), they were told, "...to sleep and eat a good breakfast, and I think that my brain functions more with more energy..."

Although the concept of both sleep and "regular" food providing energy might have been new to the teens in my study, they were very familiar with sugar and caffeine providing an energy boost, and often an accompanying crash as well. Mona, a 15-year-old Hispanic female involved in orchestra, mariachi and a variety of other activities, describes this when she talks about sugar, coffee and energy drinks.

Mona: Sometimes sugar will really make me crash after a while, and that's where coffee comes in.

KMO: ...black coffee, or coffee with stuff in it?

Mona: Coffee with stuff in it. If I'm really tired, I know this is horrible, once I downed a whole thing of coffee, it was straight, black coffee, it tasted horrible, but I was pretty much up for the whole day. I like coffee.

KMO: Do you do the energy drink thing?

Mona: I did once, never again though... I stayed up for almost two days with one of them...It was like, two Monsters and a shot of espresso. For the first hour I could feel my heart beating like boom-boom-boom-boom and I was like totally awake, I got so many things done, it was like scary, oh my God, oh my God, oh my God.

Two sleep metaphors

Teens used two major metaphors to talk about how sleep affected their bodies and brains: the car and the computer. With the car, sleep was seen as “charging the battery” to make the car go, while food provided the gas. Both were needed regularly, to get the car started in the morning and to keep it going throughout the day. Javier, a 15-year-old Hispanic male who played pick-up soccer and basketball games with friends, explains, “...sleep gets you like ... gets your body working, makes everything work... properly and then food just helps it... It’s kind of like a car...sleep is like charging the battery and, like, food’s like gas.”

The other metaphor teens used was the computer. They perceived that both the brain and the body needed to “shut down” in order to work well the next day. Cesar, a 14-year-old Hispanic male who was not involved in activities, explains:

KMO: What do you think sleep does for your body?

Cesar: I think it’s like the computer needs to shut down... in order to work properly the next day, or be more efficient, I think it’s the same way with the body. It basically shuts itself down so it can reboot and work properly the next day.

These metaphors may be particularly useful in talking to teens about improving their sleep. If they are easily able to grasp sleep as functioning like a car battery that needs to be charged (although the metaphor breaks down somewhat here, because the car’s battery is charged by running the car, not resting it), or their body as a computer that needs re-booting, they may be able to better understand the necessity of adequate of sleep.

Adolescent food intake

In any study that collects information on food intake, there is always the potential for error, especially with regard to the under-reporting of food consumed. Although I am sure that in some cases, food intake has been inaccurately reported in my sample, I sought to minimize this reporting bias through follow-up interviews, detailed in Chapter 3 and reviewed at the start of this chapter. I also stressed to my participants that I did not care what they ate, or how much they ate, because I was just exploring how sleep and food intake might go together. In order to contextualize the values seen below, **Table 26** presents United States dietary guidelines for 14-16-year-old adolescents.

Table 26: United States dietary guidelines

USDA 2005 (U.S. Department of Agriculture, 2005)	Males	Females
Guidelines on total caloric intake, ages 14-16	2000 – 3200 calories	1800-2400 calories
Dietary composition: percent of calories from fat	25 – 35%	25 – 35%

Although much of this chapter focuses on the statistical relationships between food intake, activity levels and sleep, participant observation before school, during class, and at lunch gave me a broader understanding of the kind of foods and beverages teens were consuming. From October 2006 until at least March 2007, the Future Business Leaders of America chapter at the high school operated a café before school in the science building. Students could buy bagels with cream cheese, hot chocolate, coffee, or Starbucks Frappucinos for relatively reasonable prices (for example \$1 for a coffee or hot chocolate) here before school. Before school, at lunch, and after school, vending

machines provided Vitamin Water, chocolate milk (Nestle Nesquik), baked chips and baked cheetos. I am not sure if these machines were on all day, or only turned on at the above-mentioned times. At lunch, teens could purchase meals including (most typically) hamburgers, cheeseburgers, pizza, French fries and regular or chocolate milk. “Hot lunch” was also available, as were salads, but I rarely observed students eating these items. The other option was the student store, which sold bagels with cream cheese, various types of healthy and “unhealthy” chips (Pretzels and Sunchips but also Cheetos, Doritos, Funyuns and Fritos), iced tea, and slushee drinks called “Brain Freeze” which say 100% juice on the cup (and which were good but overpriced for such a small cup, according to my key informant Billie, a 15-year-old White soccer player). I often saw teens walking around at lunch with a 20-ounce bottle of iced tea and a 99-cent bag of Sunchips. Although mainly “healthy” food was available in campus, “unhealthy” food could be brought in by students, and frequently was. During first period I documented teens drinking coffee and coffee drinks, and especially during the unofficial third-period snack time, teens often ate chips or candy, frequently sharing them among 2, 3 or even 4 people. Teens also sold “unhealthy food” to others, for example, from my field notes:

End of 4th period [right before lunch] Boy: “anybody want to buy some last minute Hot Cheetos?”

I think Marcus is selling candy - 2 girls from the other end of his row are waving dollars at him. A few minutes later he walks over (during the transition to the video) and sells some Skittles, Starburst, M&Ms for \$1 apiece.

As background for the analysis of sleep and food intake that will be presented later in this chapter, **Tables 27 and 28** below show weekday and weekend averages for caloric

intake, fat intake and caffeine intake. These variables were selected for analysis to reflect ways that teens may cope with inadequate sleep that are suggested by the existing literature, including increasing overall food intake, increasing “junk food” intake (represented by increased fat intake in this sample) or increasing caffeine intake.

Table 27: Mean and median calorie, fat and caffeine intake among adolescents on weekdays

	Calories (kilocalories)		Fat (grams)		Caffeine (milligrams)	
	Mean/ <i>Median</i>	Standard Deviation	Mean/ <i>Median</i>	Standard Deviation	Mean/ <i>Median</i>	Standard Deviation
Weekday, Overall (N=40)	2085 kcal/ 1908 <i>kcal</i>	734 kcal	73 g/ 63 g	30 g	66 mg/ 38 mg	105 mg
White (N=17)	2075 kcal/ 1885 <i>kcal</i>	519 kcal	68 g/ 62 g	25 g	64 mg/ 54 mg	59 mg
Hispanic (N=18)	2117 kcal/ 1951 <i>kcal</i>	882 kcal	79 g/ 65 g	33 g	44 mg/ 28 mg	51 mg
Male (N=20)	2501 kcal/ 2478 <i>kcal</i>	745 kcal	89 g/ 83 g	32 g	76 mg/ 43mg	134 mg
Female (N=20)	1669 kcal*/ 1711 <i>kcal</i>	432 kcal	57 g*/ 55 g	15 g	56 mg/ 34 mg	64 mg
High Activity (N=9)	2052 kcal/ 1987 <i>kcal</i>	664 kcal	74 g/ 65 g	28 g	29 mg/ 30 mg	24 mg
Medium Activity (N=14)	2131 kcal/ 1888 <i>kcal</i>	875 kcal	75 g/ 64 g	33 g	96 mg/ 56 mg	158 mg
Low Activity (N=12)	1759 kcal/ 1734 <i>kcal</i>	507 kcal	61 g/ 58 g	24 g	64 mg/ 22 mg	80 mg

* Significant difference between female and male caloric and fat intake by one-way ANOVA. For calories, $p=.000$. For fat, $p=.000$.

Table 28: Calorie, fat and caffeine intake among adolescents on weekends

	Calories (kilocalories)		Fat (grams)		Caffeine (milligrams)	
	Mean/ <i>Median</i>	Standard Deviation	Mean/ <i>Median</i>	Standard Deviation	Mean/ <i>Median</i>	Standard Deviation
Weekend, Overall (N=36)	1851 kcal/ 1733 <i>kcal</i>	724 kcal	66 g/ 60 g	37 g	61 mg/ 26 mg	81 mg
White (N=18)	1950 kcal/ 1772 <i>kcal</i>	732 kcal	66 g/ 64 g	26 g	91 mg/ 48 mg	100 mg
Hispanic (N=14)	1835 kcal/ 1778 <i>kcal</i>	776 kcal	71 g/ 62 g	51 g	37 mg/ 21 mg	42 mg
Male (N=18)	2092 kcal/ 1871 <i>kcal</i>	767 kcal	76 g/ 66 g	45 g	72 mg/ 29 mg	98 mg
Female (N=18)	1611 kcal*/ 1604 <i>kcal</i>	606 kcal	56 g/ 46 g	25 g	49 mg/ 24 mg	59 mg
High Activity (N=11)	1788 kcal/ 1646 <i>kcal</i>	873 kcal	72 g/ 59 g	55 g	25 mg*/ 0.5 mg	37 mg
Medium Activity (N=13)	2120 kcal/ 2298 <i>kcal</i>	778 kcal	69 g/ 74 g	32 g	102 mg*/ 114 mg	107 mg
Low Activity (N=12)	1619 kcal/ 1761 <i>kcal</i>	405 kcal	56 g/ 61 g	19 g	49 mg/ 28 mg	59 mg

* Significant difference between female and male caloric intake by one-way ANOVA, $p=.044$, and Significant difference between high and. medium activity caffeine intake by t-test, $p=.026$.

Looking at overall food intake and comparing the first lines of **Tables 27** and **28**, there were at least small differences in calorie, fat and caffeine intake between weekdays and weekends. In order to enable parametric statistical tests between weekday and weekend values, four of six variables (weekday and weekend average calories and weekday and weekend average fat grams) were log-transformed to reduce skewness and kurtosis within the individual distributions. For caffeine intake on weekdays and weekends, to avoid the impossibility of log-transforming zero values, average caffeine milligrams plus 5 was log-transformed. After transformation, differences in calorie, fat and caffeine intake between weekdays and weekend days were found not to be significant using paired samples T-tests on the log-transformed variables ($t(32)=1.192$, $p=.242$ for calories, $t(32)=1.545$, $p=.132$ for fat and $t(32)=1.371$, $p=.180$ for caffeine).

Although not significant, the drop in calories and fat from weekday to weekend may reflect teens' more idiosyncratic lives on the weekend. From my observations, I noticed that during the school day, certain times are marked as times for eating. Especially before school, at the beginning third period, during lunch, and immediately after school, teens often had the option to eat. They also almost always reported eating dinner either with family or alone on school days, and most ate breakfast (out of 185 weekday food-days, teens reported not eating breakfast on 21% of them). On weekends, however, many teens slept more, and some shifted their schedules to stay up later and wake up later. This differing schedule, depending upon how it fit with the schedules of other family members, may not afford as many opportunities for eating as the school-day schedule.

Looking at skipped meals, the percentage of adolescents skipping breakfast on weekends is similar to the weekday percentage (22%). The percentage of teens skipping lunch on weekends rises, however, from 14% to 18%, while the percentage skipping dinner more than doubles from 6% to 13%. This increased tendency to skip meals may also contribute to lower caloric intake on the weekends.

To examine whether there were any broad differences in total caloric intake, fat, or caffeine intake within my sample, I stratified these food variables by ethnicity, gender, and activity level. After the variable transformations described above, each variable was compared across gender, ethnicity and activity level categories, using one-way analysis of variance (ANOVA) to compare means.

Ethnicity

Although I collected food data from several teens who were African American, Native American, and Native American/White, the ethnicity portions of **Table 27 and 28** above are limited to only White and Hispanic teens, for whom my sample was largest. As seen in the tables above, no significant differences were detected between White and Hispanic teens in the variables examined.

Gender

On weekdays, girls eat significantly less than boys as measured by one-way ANOVA. This can be seen in mean calories, $F(1,38) = 19.736, p=.000$, and also mean fat grams $F(1,38)=18.451, p=.000$. On weekends, girls also ate significantly fewer calories

($F(1,34)=4.368, p=.044$) than boys. These differences in food quantity make sense, as boys in this sample are, on average, significantly taller and heavier than the girls as compared using one-way ANOVA ($F(1,48)=47.034, p=.000$ for height, $F(1,48)=11.622, p=.001$ for weight). They also differ (although not significantly) in BMI, with males averaging 24.52 while females average 22.96. It also may be that girls are dieting or “watching” what they eat more than boys (Nichter, 2000), although I did not ask teens in my study specifically about dieting or “watching” behavior on the days they kept food data.

Referring to **Tables 27 and 28**, girls consume less caffeine than boys, but this reflects an overall gender difference in intake that is not unique to caffeine. Looking at the highest and lowest consumers of caffeine, whose specific intake is discussed below, gender does not make a difference with regard to caffeine intake. The ten highest and lowest caffeine consumers are both evenly split between males and females.

Activity level

In **Tables 27 and 28**, I examine differences among high, medium and low-activity teens. These categories were calculated from activity diary data, as described in Chapters 3 and 6, in order to provide a more nuanced analysis of variation in activity than it was possible to achieve using the self-report activity measure that I used as part of my sampling strategy, detailed in Chapter 3.

On weekdays, food intake matches activity level, with high activity teens consuming more calories and fat than medium or low activity teens, although these differences are not significant. On weekends, medium-activity teens consume the most calories on average, although the fat gradient from high to low remains. Caffeine does not follow this high-to-low pattern, however. On weekdays and weekends, teens with a medium activity level consume the most caffeine, followed by low activity teens. High activity teens consume the least caffeine, on weekdays and weekends. On weekends, differences between high, medium and low-activity teen caffeine consumption are significant by one-way ANOVA, $F(1,22)=4.241$, $p=.051$. High activity teens consumed less caffeine than both medium activity teens and low activity teens. T-test comparisons revealed that high activity teens' caffeine intake differed significantly from medium activity teens' intake, $t(15) = 2.458$, $p=.026$. Low-activity teens' caffeine intake did not differ significantly from medium activity teens' intake, $t(23) = -1.536$, $p=.138$. The high activity teens also did not differ significantly from the low-activity teens in caffeine intake, $t(21) = 1.170$, $p=.255$. This low caffeine intake by high-activity teens may reflect better sleep for these physically active teens, or may be related to "staying in shape" for sports activities.

Focus on caffeine

Beyond overall food intake, caffeine intake is particularly interesting in teenagers because, as they themselves point out, consuming caffeine is sometimes an effective way to combat too little sleep. One way to examine this sleep-caffeine relationship might be

to compare caffeine intake on weekdays and weekends, expecting that these may be lower on the weekends, when teens are (presumably) sleeping more. Referring to **Table 27 and 28** above, caffeine intake *does* decline slightly (but not significantly) on the weekends as compared to weekdays, but this is a pattern seen in fat intake as well, as overall caloric intake drops from weekday to weekend. Although this data does not support much of a weekend drop in caffeine intake, examining the number of teens abstaining from caffeine provides some evidence that there is a real drop in caffeine use on the weekend. On weekdays, only 3 out of 40 teens (7.5%) reported an average of 0 mg of caffeine. On weekends, the number of teens reporting 0 mg of caffeine rises to 9 out of 36 (25%).

In order to investigate the food and drink sources of caffeine consumed by this population, I ranked the weekly average intake of milligrams of caffeine and selected the ten teens with the lowest averages and the ten teens with the highest averages. I then explored individual food records for three weekdays completed by all participants in order to determine ounces of various beverages consumed (regular soda, diet soda, coffee, tea, energy drinks, water, milk, etc.). Mean ounces of various types of caffeinated beverages are recorded in **Table 29**, below.

Table 29: Ounces of caffeinated beverages, comparing low and high caffeine consumers on 3 weekdays

	Average milligrams of caffeine consumed over 3 weekdays	Mean ounces of caffeinated soda	Mean ounces of non-caffeinated soda	Mean ounces of coffee and coffee drinks	Mean ounces of tea	Mean ounces of hot chocolate	Mean ounces of energy drinks
Low-caffeine consumers (n=10)	5.34 mg	0.00	8.00	0.00	9.55	0.60	0.00
High caffeine consumers (n=10)	179.34 mg*	62.30	18.40	14.80	9.60	2.40	21.60

* Significantly different by one-way ANOVA, $p=.000$

Comparing beverages consumed by low-caffeine consumers (average of 0 to 11 mg of caffeine across weekdays) and high-caffeine consumers (average of 70 to 624 mg of caffeine across weekdays), it is clear that these groups consumed radically different amounts of caffeine ($F(1,18)=40.687$, $p=.000$), and that soda made a big difference in caffeine consumption. None of the low-caffeine consumers drank regular or diet soda. For high-caffeine consumers, however, 9 out of 10 drank regular or diet soda, with quantities ranging from 20 ounces to 133 ounces across three weekdays. In addition, these nine soda drinkers also drank additional caffeinated beverages, such as coffee (3 of 9), coffee drinks, like those sold by Starbucks, which I separated from coffee because of their inherently high sugar *and* caffeine content (2 of 9), and hot chocolate (2 of 9). One soda-drinker also drank tea (mostly iced tea, which was a caffeinated beverage available at the school), and one male, who only consumed 20 oz of soda, consumed a vast

quantity of energy drinks (216 oz over 3 days!). Although a number of teens in my sample did say they consumed energy drinks on occasion, only this individual, Lucas, introduced above, drank them on a regular basis. The exchange below with David, a 15-year-old White male who ran track and cross-country, is more typical of the views of most teens in my sample towards energy drinks.

David: Well, maybe if I'm tired I'll buy an energy drink...

KMO: Do you like any particular energy drink?

David: Not really. They're all pretty bad.

KMO: So, you're just going for the caffeine effect –

David: Yeah.

The quote from Lucas, who disliked soda and asked his mother to buy energy drinks, indicates that he felt obliged by his mother to drink them once they were in the house.

Cause my mom goes out and she buys these cases for me, you know like the Full Throttle and all that. And I have to drink one every day or she “oh, you make me go out and buy these for you and you don't even drink 'em” It's kinds hard to drink cause it comes in what, a pack of six? Like Monsters and all [in a 20-ounce can]. Yeah and it costs her \$35 just to buy this little case of Voodoo and when she can go to Food City and buy BooKoo and it's like a little cheaper but it tastes good, real good. And yeah, it's pretty much what it is, that's what I drink. (Lucas, 15)

Activity overview

When calculating activity levels and durations, I used the same criteria for exclusion of an activity-day as I did for exclusion of a food day. The rationale behind this choice was that if a teen was sick, or experiencing other circumstances that made their food intake abnormal, it is likely that their activity would be affected as well.

Table 30: Weekday duration of physical activity for adolescents

	Mean Duration of Activity	Standard Deviation
Weekday (N=40)	1 hour 32 mins	1 hour
Male (N=20)	1 hour 44 mins	1 hour 5 mins
Female (N=20)	1 hour 21 mins	55 mins
White (N=17)	1 hour 30 mins	48 mins
Hispanic (N=18)	1 hour 38 mins	1 hour 12 mins
High Activity	2 hours 4 mins ^a	1 hour 8 mins
Medium Activity	1 hour 45 mins ^b	1 hour
Low Activity	44 mins ^{a,b}	24 mins

^a Significant difference between high and low activity by t-test, $p=.008$

^b Significant difference between medium and low activity by t-test, $p= .003$

Table 31: Weekend duration of physical activity for adolescents

	Mean Duration of Activity	Standard Deviation
Weekend (N=35)	2 hours	1 hour 32 mins
Male (N=18)	2 hours 20 mins	1 hour 36 mins
Female (N=18)	1 hour 39 mins	1 hour 27 mins
White (N=18)	1 hour 56 mins	1 hour 8 mins
Hispanic (N=14)	1 hour 55 mins	1 hour 54 mins
High Activity	2 hours 56 mins*	1 hour 13 mins
Medium Activity	1 hour 58 mins	1 hour 20 mins
Low Activity	1 hour 10 mins*	1 hour 37 mins

* Significant difference between high and low activity by t-test, $p=.008$

Examining **Tables 30 and 31**, the amount of time teens spent doing physical activities increased significantly as measured by paired t-test comparison from weekday (1 hour 32 minutes) to weekend (2 hours) ($t(34)=-2.050$, $p=.048$). This difference was most likely due to a combination of free time on the weekend during which adolescents engaged in physical activity, and parents' assignment of weekend chores that had a physical activity component. When looking at weekday activity broken down by gender and ethnicity, all groups show similar durations of activity. However, as expected, a one-way ANOVA of duration of activity by activity level on weekdays (computed from mean daily METS) was significant, $F(2,32)=6.782$, $p=.004$. On weekdays, duration of activity was greatest for high-activity adolescents and declined for medium and low activity adolescents. T-test comparisons revealed that high activity teens' duration of activity differed significantly from low activity teens' duration, $t(10) = -3.340$, $p=.008$. Medium-activity teens' duration also differed significantly from low activity teens' duration, $t(18) = -3.459$, $p=.003$. The high activity teens did not differ significantly from the medium-activity teens in duration, $t(21) = -.698$, $p=.493$.

On weekends, average duration of activity does not differ significantly across gender or ethnicity, although males and females do show almost a 40-minute difference in mean duration of activity on weekends. As on weekdays, the one-way ANOVA of duration of activity by activity level on weekends was significant, $F(2,33) = 4.574$, $p=.018$. On weekends, teen activity followed the same high-medium-low gradient seen on weekdays. T-test comparisons showed that high activity teens were active significantly longer than

low activity teens, $t(21) = -2.951$, $p=.008$. Medium-activity teens duration of activity did not differ significantly from that of low-activity teens, $t(23) = -1.376$, $p= .182$. Comparing high activity and medium activity teens also revealed no significant difference in duration of activity, $t(22) = -1.817$, $p=.083$.

Relationships among sleep, food and activity

Sleep and total calories, fat and caffeine

Although sleep and food clearly have a bi-directional relationship – that is, how one sleeps has some effect on food intake the next day, and how (and what, and when) one eats has an effect on sleep the next night – this analysis will focus only on food and drink intake following a night of sleep. The dependent variables for this section of analysis are total caloric intake, fat intake, and caffeine intake. The main independent variable is total sleep time (TST). In addition to calculating relationships between TST and the food variables for the sample as a whole, I also present relationships between these variables after dividing the sample into short, average and long sleepers on the nights in question in order to address changing one's food and drink intake as a potential coping behavior, given teen participant's perception of sleep and food as different but complementary ways of obtaining energy.

To analyze the sleep-total caloric intake relationship, I calculated one-tailed Pearson correlations between TST each night and caloric intake, fat intake and caffeine intake for the following day, shown below in **Table 32**, following the hypothesis that lower sleep

time would increase calorie, fat, and caffeine consumption in teens. These correlations were controlled for BMI and gender, as females tended to have a significantly lower caloric intake, as seen above in **Tables 27 and 28**. All individuals excluded above on the basis of known problems with their sleep or food intake were also excluded from this analysis.

Table 32: Pearson correlations (one-tailed) between total sleep time and next-day total calorie, fat, and caffeine intake, controlling for gender and BMI

Correlation between Total Sleep Time and next-day:	Weekday 1 (N=34)	Weekday 2 (N=34)	Weekday 3 (N=33)	Weekday 4 (Monday) (N=30)	Saturday (N=31)	Sunday (N=34)
Total Caloric Intake	.038	-.134	-.071	-.147	-.383*	-.378*
Fat intake (grams)	.119	.007	-.268	-.027	-.298*	-.547*
Caffeine intake (milligrams)	-.129	-.093	-.058	-.040	-.331*	.017

* Significant Pearson correlation, controlling for gender and BMI, $p < .05$

For these comparisons, weekend values were significantly correlated with night-before total sleep time. On Saturday, calories ($r(29) = -.383$, $p = .017$), fat ($r(29) = -.298$, $p = .051$) and caffeine ($r(29) = -.331$, $p = .035$) all showed significant negative correlations with night-before total sleep. On Sunday, caffeine was not associated with sleep, but calorie ($r(32) = -.378$, $p = .014$) and fat intake ($r(32) = -.547$, $p = .000$) continued to show significant negative correlations with night-before total sleep.

Following this analysis, given significant findings only for weekend nights, I examined the total sleep time – food and drink relationship by dividing each *weekend* night's sleep into quartiles, detailed in **Table 33** below.

Table 33: Weekend total sleep time quartiles

Quartile	On 2 weekend nights, slept, on average
Bottom 25%	Less than 7 hours 20 minutes
26 – 50%	7 hours 21 mins to 8 hours 36 mins
51 – 75%	8 hours 37 mins to 9 hours 35 mins
76% +	9 hours 36 mins to 12 hours

Those teens who slept the least consumed more calories and fat, with a steady (though non-significant, by one-way ANOVA) decline in calories and grams of fat among teens who slept more (See **Figures 16 and 17** below). T-test comparisons showed that not even the largest absolute differences in values, between the lowest 25 % of sleepers and those who slept the most (76%+) were statistically significant, $t(10) = 1.407$, $p=.189$ for calories, $t(16) = 1.051$, $p=.326$ for fat and $t(16) = 1.074$, $p=.299$ for caffeine.

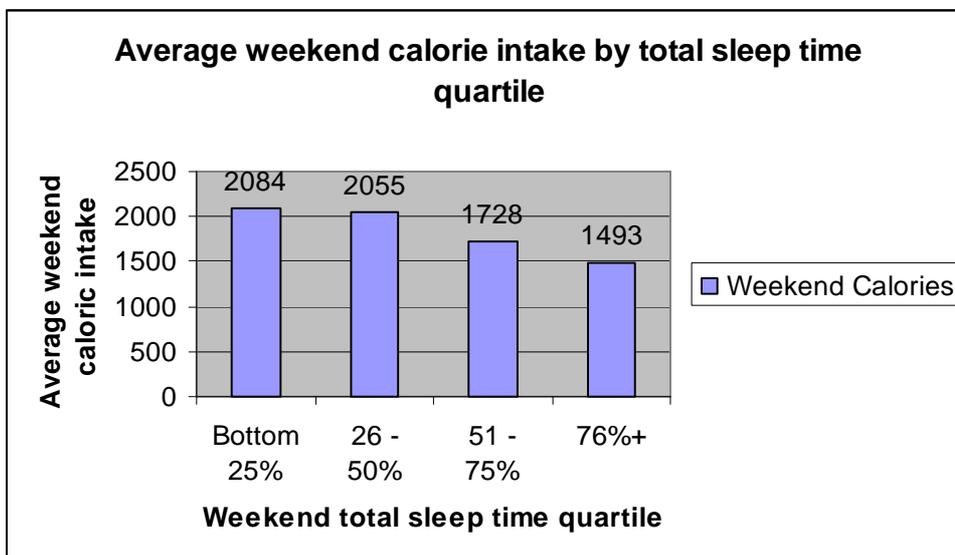


Figure 16: Average weekend calorie intake by total sleep time quartile

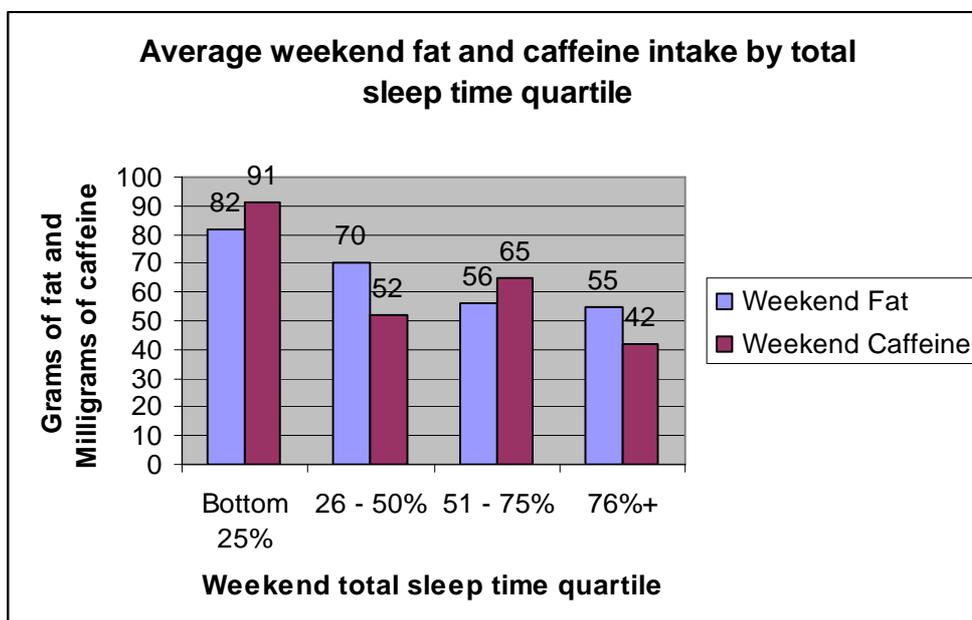


Figure 17: Average weekend fat (g) and caffeine (mg) intake by total sleep time quartile

Total calories, fat and caffeine among short and long sleepers

Using the same criteria for short and long sleepers introduced in Chapter 6, **Table 20**

(approximately 6.5 hours or less on weekdays and weekends for short sleepers, and more than 8 hours on weekdays or 10+ hours on weekends for long sleepers), I compared next-day total caloric intake, fat intake and caffeine intake among short, average and long sleepers for 4 weekdays and 2 weekend days (See **Table 34**).

Table 34: Total calorie, fat and caffeine intake across weekdays and weekends, by sleep status

		Weekday 1 (N=7, 16, 13)	Weekday 2 (N= 9, 15, 12)	Weekday 3 (N=6, 20, 9)	Weekday 4 (Monday) (N= 9, 14, 9)	Saturday (N=8, 17, 8)	Sunday (N=5, 25, 6)
Total Caloric Intake	Short	2198	1889	2290	1674	2146	2438
	Average	2314	2110	1828	1855	1851	1994*
	Long	2647	1587	2053	1902	1333	1187*
Fat Intake (grams)	Short	73	53	88	60	79	110
	Average	81	82	68	65	59	71*
	Long	109	50	69	62	49	34*
Caffeine intake (milligrams)	Short	100	193	48	16	94	105
	Average	46	50	130	46	63	60
	Long	67	60	51	25	16	25

* Significant difference between average and long sleepers by t-test, $p < .05$

Analysis of differences in total caloric intake, fat intake and caffeine intake on weekdays and weekend days across sleep status shows the same pattern of food and drink differences appearing more strongly on the weekend. Fat intake differs significantly by one-way ANOVA across groups on Sunday, $F(2,33) = 4.339$, $p = .021$, while Sunday caloric intake is marginally significant across groups, $F(2,33) = 3.073$, $p = .060$.

Comparing sub-groups via t-tests shows that fat intake for the short-sleep group does not differ significantly from the long-sleep group $t(5) = 4.606$, $p=.091$ due to a high degree of variance in the short-sleep group (Levene's test for equality of variances $F=5.778$, $p=.040$). The same problem affects the significance of the short-average sleep and fat intake comparison, $t(4) = 1.095$, $p=.330$. The average and long sleep groups, however, with similar variance values, have significantly different fat intakes, $t(29) = 2.323$, $p=.027$. Variance issues also plague the Sunday calorie comparisons (Levene's test $F=6.869$, $p=.028$), but the average and long sleep groups, with similar variances, are significantly different in their caloric intake, $t(29) = 2.169$, $p=.038$.

Sleep and activity duration

To test for relationships between inadequate sleep and next-day activity duration, I calculated Spearman correlations between daily duration of activity and both total sleep time and wake after sleep onset (WASO). Spearman correlations were used due to the persistent non-normality of duration of activity and WASO distributions, even after data transformation.

Table 35: Spearman's Rho correlations between duration of activity and night-before total sleep time and wake after sleep onset

Correlation between duration of activity and night-before:	Weekday 1 (N=36)	Weekday 2 (N=36)	Weekday 3 (N=35)	Weekday 4 (Monday) (N=32)	Saturday (N=33)	Sunday (N=36)
Total Sleep Time	-.178	-.095	-.102	-.293	-.329(*)	-.366*
Wake After Sleep Onset	-.054	.094	-.074	.192	.262	.228

(*) Rho(33)=-.329, p=.061, * Rho(36)=-.366, p=.028

The relationship between duration of activity and night-before total sleep time shows a marginally significant negative correlation on Saturday (Rho(33)=-.329, p=.061) and a significant negative correlation on Sunday (Rho(36)=-.366, p=.028). WASO is not significantly associated with next-day activity duration on any day.

Comparing mean weekend duration of activity across sleep quartiles reveals that teens who sleep less generally engage in physical activity for a longer duration than teens who sleep more. The differences across these activity values are statistically significant by one-way ANOVA, $F(3,29)=2.889$, $p=.052$. Individual t-test comparisons show that this significant finding is driven by the difference between the 26-50% quartile and the 76%+ quartile, $t(16)=3.043$, $p=.008$.

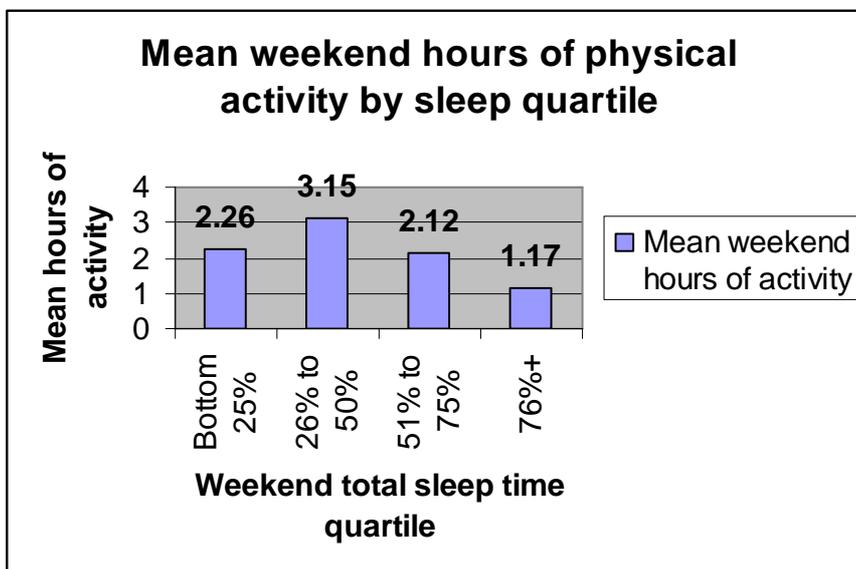


Figure 18: Mean weekend hours of physical activity by sleep quartile

Activity duration among short and long sleepers

Comparing short, average and long sleepers reveals that activity duration does not vary by sleep status on weekdays, but that a relationship is evident on the weekends. Using the Kruskal-Wallis test because of the non-normality of the activity duration variable, the relationships between Friday night sleep and Saturday activity $\chi^2(2) = 5.166$, $p=.076$ is marginally significant. Testing subgroup differences with the Mann-Whitney U test reveals a significant activity-duration difference ($U(1) = 32.500$, $Z = -2.071$, $p=.038$) between individuals with average sleep ($N=17$, 2 hours and 55 minutes of activity) and long sleep ($N=8$, 1 hour and 12 minutes of activity). The Saturday night sleep and Sunday activity relationship is also significant overall, $\chi^2(2) = 6.235$, $p=.044$. Sub-group comparisons with the Mann-Whitney U test showed a significant difference between short ($N=5$, 2 hours and 43 minutes of activity) and average ($N=25$, 1 hour and 28

minutes of activity) sleepers, $U(1) = 26.500$, $Z = -2.011$, $p = .044$. The difference between short and long ($N=6$, 47 minutes of activity) sleepers was also significant, $U(1) = 2.000$, $Z = -2.379$, $p = .017$.

Changing food intake or activity patterns as a way of coping?

Total calorie, fat and caffeine intake

While teens who slept less on the weekends may have consumed more calories, interview data made it clear that this was not a conscious way of coping with sleeping too little.

Most adolescent participants in my study, like Katie, a 14-year-old White female in the marching band, said that if they slept less, they would generally eat less, mainly because they would not have the energy to make and/or consume food, “But then if I get like little sleep, I don’t really feel like eating, like I just feel like sleeping and I then I might be too tired to, like, get out of bed and too tired to actually go and have the effort to cook something, so yeah.” Others, like Antonio, a 14-year-old Hispanic male who played basketball and baseball, noted that there probably was not any relationship between how they slept and how they ate:

KMO: ...if you sleep less, do you eat more or do you eat less?

Antonio: Eat less. Well, for me, it just don’t matter, ‘cause I eat anyway.
(Laughs)

Antonio’s initial response was to say sleeping less would lead to eating less, but then he quickly moved on to say he did not think this pattern applied to him. As mentioned above, teens did see a relationship between inadequate sleep and caffeine intake. As for

the relationship between sleep and junk food intake (for which fat intake is a proxy here), many teens had observed no relationship in their own eating patterns. I suspect this is because a teen's diet, especially on weekdays, is rather circumscribed by the food available to them. These 14 and 15-year-old adolescents may be able to express preferences for what types of food parents buy, but they are probably not responsible for acquiring most of the food they consume. As Connor, a 14-year-old White male who played in the marching band noted when I asked him how he thought his sleep might affect his food choices the next day, "I don't know. I think what my mom buys at the grocery store affects what I eat." Harry, another 14-year-old White male in marching band, explained how lack of sleep might lead to less-healthy food choices, "If you're tired you won't like, want to fix something, so you like, order in something that might not be too healthy." Finally, several teens expressed a paradoxical craving for both healthy foods and items they perceived as unhealthy (high in sugar or caffeine) when they were tired, like Mona, introduced above:

Yeah 'cause sometimes when you're tired if you're hungry and you actually can eat, I notice that when I'm tired, if I eat... I want to eat like vegetables and stuff like that and sometimes I want to have a big, big, big candy bar to wake me up. Like, "chocolate!" Yep, sugar is good for that. (Mona, 15)

For futures studies with adolescents in this age range, a clearer question, such as "Do you feel hungrier when you've slept less?" would add to the clarity of teen responses. I also discussed elements of my study with older teens at the high school where I worked, and found that juniors and seniors were much more articulate about their sleep experiences,

and might also be likely to have a better understanding of the relationships between sleep and food consumption for them.

Coping by altering calories, fat or caffeine consumed, did not, for the most part, vary significantly by gender, ethnicity, or household composition. Only two weekday subgroup comparisons, and one weekend comparison, showed significant differences. On weekdays, males and females in the both the second sleep quartile (sleep in the 26 – 50th percentile) and the top 25% of sleep time (76%+) consumed significantly different numbers of calories, as tested by one-way ANOVA, with males consuming more. Second-quartile males (N=3) consumed 2263 calories, on average, to females (N=5) 1326 calories ($F(1,6)=7.060$, $p=.038$). Top-quartile males (N=3) consumed 2291 calories, on average, to females (N=4) 1767 calories ($F(1,5)=7.228$, $p=.043$). On weekends among the shortest sleepers (bottom 25%), caffeine intake varied significantly by household composition, with teens who lived with one parent (N=4, mean caffeine =169.6 mg) consuming significantly more weekend caffeine than teens who lived with both parents (N=4, mean caffeine =12.5 mg), $F(1,6)=21.680$, $p=.003$.

Physical activity patterns

As with the relationships between total sleep time (TST) and diet variables, it is likely that most teens are not making conscious choices about exercise in response to the quantity of their sleep. Especially during the week, but also on the weekend, teens who are freshmen in high school probably have very little leeway in their activity patterns, no matter the quantity or quality of their sleep the night before. Almost all participated in a

mandatory physical education class at the high school, and to receive an adequate grade there, they could not reduce their activity too much. Teens who played sports also had certain activity requirements that could not be reduced in the face of simple tiredness. Although the TST and activity duration results on the weekend make sense in light of reduced time awake to engage in physical activity, it still seems paradoxical that teens who obtained the least sleep on weekends engaged in the most activity. A comment from Mike, introduced above, however, may begin to explain this paradox, and emphasizes the interrelated nature of sleep, food and activity:

Mike: I don't know, I guess like, I really don't think about my energy. I just eat if I'm hungry, and I sleep if I'm tired, and if I think I need more energy, I usually go do something that's athletic.

KMO: Does that energize you, instead of making you feel more tired?

Mike: Yeah. But then I'm hungry again.

In addition to this comment, other participants also remarked that physically moving around within the classroom, when permitted, and outside helped them to combat sleepiness during the school day.

Coping by altering physical activity did not vary by gender, ethnicity or household composition, with one exception. Among the shortest sleepers (bottom 25%) on weeknights, teens who lived with both parents (N=6, mean duration of activity 2 hours and 24 minutes) engaged in a significantly longer duration of physical activity than teens who lived with only one parent (N=3, mean duration of activity 35 minutes).

Conclusion

At the start of this chapter, I hypothesized that if teens get less sleep, or poorer quality sleep, they will increase their total caloric intake, fat intake and caffeine intake the following day. The overall data supported this hypothesis on the weekends, especially for calories and fat, although the declines in these variables were not statistically significant across sleep quartiles. Comparing teens who experienced short, average or long sleep on the night before, differences across calorie, fat and caffeine intake were once again more pronounced on the weekends, and showed significant or marginally significant differences across groups for calorie and fat intake on Sunday. While these comparisons were hampered by high variance in calorie, fat and caffeine intake among short sleepers, significant mean differences could be detected between some subgroups. A possible explanation for why teen food and drink intake is more strongly associated with sleep on the weekends is that on weekdays, teens have limited time and money for obtaining food before and after school, and coupled with the school's closed-campus policy, these environmental and personal factors limit teen's food and drink choices.

My second hypothesis, that teens with more disrupted sleep will decrease their physical activity, was not supported. Duration of activity showed no significant correlation with wake after sleep onset (WASO) on any day. Lower amounts of total sleep time were associated with next-day activity duration on the weekends, but not in the expected direction. Although the longer durations spent in physical activity by shorter sleepers may simply reflect more hours awake to be active, the relationship still seems

paradoxical. Comments by several teen participants about being active as a way to combat sleepiness may begin to unravel this paradox, as might further investigation of individual perceptions of sleep need in relation to activity data. Both the food intake and activity results offer interesting possibilities for future research. Although I set out to test directional hypotheses about the effect of short sleep on food intake and activity levels, ultimately these data highlight the larger picture of interconnected sleep and coping behaviors as they play out in daily life when sleep is either adequate or inadequate for these teenagers.

CHAPTER 8: CONCLUSION

Sleep matters. It matters for people of all ages, but adolescents, due to the confluence of biological, cultural and environmental factors, are particularly vulnerable to sleeping too little. They are most often biologically phase-delayed as a function of puberty, wanting to stay up later and get up later. Schoolwork demands, after-school activities and social lives, coupled with personal communication and entertainment technology, often available 24/7, tend to preclude sleep. Given late nights, which are driven by a combination of biological and social influences, high school starts much earlier in the morning than most teens are ready to learn. Studying sleep in teens is timely not only because the popular press has seized on this issue in the last few years, making teens, parents and teachers much more aware of the complex web of interacting factors that result in adolescents sleeping too little. It is also timely because this media attention, coupled with scientific research results in the lab and in schools, has shown that sleep is an essential health behavior. Sleeping an appropriate amount is *at least as important* as eating well and engaging in physical activity for maintaining both physical and mental health. National campaigns address “eating right” and being more active, but sleep is often ignored. Sleep behavior, sleep need, and coping with inadequate sleep are seen as individual, as private, as something that the schools do not have the time or resources to tackle. After all, students are awake and learning in school, not sleeping, right? This research revealed that teens obtain small amounts of information about sleep from multiple sources including parents, friends, the media and their own experience, but that these “sleep soundbites” often conflict. As with any lifestyle intervention, the question

becomes, “who is responsible for making sure teens get adequate sleep?” The answer is still unclear, but the myriad consequences of inadequate sleep, especially for teens, mean that this is a question that should be answered sooner rather than later. This conclusion first revisits the negative consequences of inadequate sleep in the short and long term, described in Chapter 2, briefly summarizes the main findings of the study, and then turns to a concise enumeration of the specific strengths of this research and its limitations, concluding with questions for future research.

Short and long-term consequences of inadequate sleep for adolescents

As detailed in Chapter 2, inadequate sleep has many negative consequences that are directly relevant to the everyday functioning of adolescents. In addition, research on the long-term costs of sleep loss reveals some of the difficulties adolescents may face in the future. Teens who do not sleep enough are more likely to report higher levels of depression and anxiety, as well as lower levels of self-esteem. Chronic inadequate sleep has also been linked with substance abuse, most recently through Mednick and colleagues’ (2010) social network analysis of the relationships among friends and peer effects on poor sleep and marijuana use. Other short-term effects of sleep loss include an overall decrease in control of drives, impulses and emotions, including those related to paying attention, concentrating, and taking impulsive action. This, coupled with poorer performance on tasks requiring cognitive processing and/or quick response, can lead to poor grades for teens. Studies have also shown that inadequate sleep severely

compromises simultaneous cognitive, social and emotional processing. In other words, trying to think, work with people, and manage emotional situations – the kind of multi-tasking engaged in practically every day by teenagers – creates a worst-case scenario for the sleep-deprived brain. Finally, teens who do not sleep enough may be more likely to get sick, due to reduced immune function, and also to be involved in automobile accidents. In the long term, chronic sleep problems such as insomnia have been linked to later development of depression, and some research has shown that problems sleeping, evidenced by daytime sleepiness in childhood, may be linked to substance abuse problems later in life. Short sleep has also been linked to higher body mass index (BMI) through multiple mechanisms, including sleep's alteration of the appetite hormones leptin and ghrelin, and also decreased physical activity. Although longitudinal studies on humans have not been done, it is possible that inadequate sleep during critical periods of brain development, including adolescence, may lead to rewiring of the brain in some way, especially in the prefrontal cortex that controls drives, impulses, emotions and goal-directed behaviors. Finally, poor sleep in adolescence may prepare teens for sleep problems that continue across emerging adulthood and into adulthood. Having learned to expect only inadequate sleep as teens, or trade sleep for time spent in more “rewarding” activities, these adolescents may continue to sleep poorly.

Summary of findings

Over the course of 13 months between October 2006 and November 2007, I engaged in participant observation and semi-structured interviews with 50 teens who were all 14 or

15 years old, and freshmen in high school at the start of the study. The study took place at a single high school in Tucson, Arizona that enrolled nearly 3000 students, 848 of them freshmen. To construct a comprehensive picture of my participants' sleep and how it affected their waking lives, I coupled interviews and participant observation with a group of diaries and questionnaires designed to capture sleep, food intake, physical activity and technology use from the same cohort of adolescents. The resultant volumes of data helped me to answer the key questions of this research. These questions were informed by biocultural anthropology theory, especially a biocultural model that privileges interactions among biology, culture and environment, and a model of sleep behavior, and the coping behaviors that spring from inadequate sleep, as embodied and negotiated within the social worlds of adolescents. Below, I briefly summarize key findings related to each research question.

- ❖ **How do adolescents in this population perceive their own sleep?** This includes an examination of factors that they think affect their sleep, their perceptions of sleep need and ideas about sleeping too much and too little, and their sources of information about sleep.

A variety of factors contributed to sleep loss among the teens in this population. Reasons that were particularly prevalent on weekdays included early school start times, homework, a variety of after-school activities that sometimes kept teens busy until 9 pm or later, and various types of technology use. This technology use, which of course was not limited to weeknights, included things like calling or texting friends on the cell phone, sending instant messages or MySpace messages on the computer, playing games on the computer or gaming system, and watching TV. On weekends, activities including

music competitions, sports games, work with family businesses, church, and volunteer work limited sleep. In addition, the abovementioned technology use also interacted with sleep on the weekends, sometimes more so than during the week because parents did not restrict it as much as they did on weeknights. Family factors, such as parents' expectations and younger siblings' early wake times, affected teen sleep on both weekdays and weekends. Teens also expressed frustration at their internal "body clocks" which often woke them at the same time on weekends as during the school week, after which they found themselves unable to return to sleep. During the summer, teens had fewer constraints on their time, although some were still involved in working for family businesses and caring for siblings during the summer, which limited their sleep time.

How much sleep do teens believe they need, and what are the consequences associated with sleeping too little and too much?

Teens believe they need slightly more sleep than they are getting on the weeknights (a mean of 7 hours 48 minutes, compared with the mean 7 hours 13 minutes), and they feel they are actually sleeping fine on the weekends (desiring a mean of 8 hours 12 minutes, versus the 8 hours 28 minutes they got, on average.) For many teens, sleep amounts below 5 or 6 hours were definitely "too little." Without sleep, teens felt tired, sluggish, weak and drained physically. Males, especially, tended to emphasize that without enough sleep, they couldn't do physical things that they normally expected of their bodies. Teens said that mentally, they felt as if they were operating on autopilot, mindlessly moving through their day. They might fall asleep in class, but even if they stayed awake, they

were barely able to participate because their brain processing slowed down. Emotionally, teens felt more cranky, grumpy, sad and easily irritated.

Sleeping too much often felt like sleeping too little for these teens. A few described feeling invigorated and full of energy, but many said they were just as tired and lethargic when they woke after sleeping too much as they were when they slept too little. A number of teens described sleeping too much as “lazy,” both in the context of not being able to get out of bed and do anything after a long period of sleep, but also more pejoratively, commenting that they (and often their parents) felt that sleeping too much was “lazy” behavior that should be avoided.

What sources of information do teens rely on to learn about sleep?

Although previous research pointed to parents, teachers and coaches as sources of sleep information, of those three, only parents and teachers played a salient role for this sample of teens. Parents, especially those with a medical background, were seen as authorities on the benefits of sleep, and teachers mostly stressed to teens that they probably needed more sleep, rather than including any sleep information in their curriculum. Teens also relied on their own experience quite a bit to learn more about sleep, specifically what kind of sleeping patterns and durations worked for them, and which did not. Finally, a few teens saw media messages, either TV programs, or commercials for mattresses and sleeping pills that spoke to them. Such commercials were the most obvious connection to the “sleep industrial complex” for teens, but other than remembering them as unique or funny (the Rozerem commercials with Abe Lincoln playing chess with a beaver) or

having a memorable icon (the green glowing butterfly of Lunesta), these commercials did not provide teens with any concrete knowledge about sleep. I contend, however, that as these teens grow into young adults who may still have some problems sleeping (or whose sleep problems may be exacerbated when they move to the less-structured setting of college), the sleep industrial complex may play a larger role in their lives.

❖ **What constitutes "normal sleep" in this population of adolescents?**

“Normal” sleep in this adolescent population, as expected, varied across weeknights, weekend nights and summer nights. On weeknights, the 50 teens who kept sleep diaries slept an average of 7 hours 13 minutes. On weekends, many (but not all) of the 44 teens who kept sleep diaries slept longer, with a mean of 8 hours and 28 minutes sleep. During the summer, 20 teens kept diaries and reported an average of 8 hours and 6 minutes of sleep.

Differences in sleep by ethnicity, gender and activity level

Adolescents in this population showed some small differences in sleep across ethnicity, gender, and activity level. Between White and Hispanic teens, White teens tended to sleep slightly longer and more soundly than Hispanic teens on weeknights. Hispanic teens also took much longer, on average, to fall asleep (over 41 minutes vs. less than 17 minutes for White teens). On weekends, Saturday-night sleep varied, with Hispanic teens sleeping more than 1 hour less than White teens. As this was typically the biggest “catch-up sleep” night for teens in this population, this poor sleep might have been even more detrimental for Hispanic teens than poor sleep that occurred on another night.

Between males and females, males tended to sleep marginally longer than females during the week, and also reported slightly higher-quality sleep, while females slept somewhat longer on the weekends. Females reported significantly lower mean sleep quality on weeknights, although on the weekend male and female sleep quality were more similar. Sleep variables also did not differ greatly among high, medium and low activity teens. Only weeknight total sleep time showed a significant difference across activity levels.

Overall, factors that contributed to sleep loss in this teen population did not seem to differ across ethnicity, gender, or activity level. Almost all teens had experiences of sleep loss related to activities, family factors, and technology use. My sample was made up of a mix of students in the honors science classes and regular science classes; from observation in those classes, honors students probably had more homework that affected their sleep than did students in the regular classes. White teens were more likely to be represented in the Honors classes than Hispanic teens, so an ethnic difference might be seen there upon further analysis.

How do household dynamics affect adolescent sleep?

This research only began to examine household effects on teen sleep, and this is definitely an area where extensive further research can and should be conducted. Within this study, I documented positive correlations between parent and teen bedtimes and wake times, and also showed an effect of older and younger siblings on teens' bedtimes

and wake times. Teens with older siblings went to bed and got up slightly later than the overall average bed and wake times, while teens with younger siblings went to bed and rose earlier than the overall mean. Anecdotally, parental rules about sleep often caused teens to go to bed (or at least think about going to bed) earlier, and parents often had control over teen wake times, as they functioned as the alarm for their sons or daughters.

❖ **What are specific ways in which adolescents cope with inadequate sleep? Do strategies vary with regard to household composition, gender, or ethnicity?**

Adolescents do cope with inadequate sleep by changing their sleep behavior, although it is not clear how many do this consciously. When asked directly about how they might make up for lost sleep, teens talked about napping and sleeping longer, especially over weekends and breaks. These responses did not differ by ethnicity, but they did differ somewhat by gender, with females being more likely to say they didn't need to "catch up" because they slept enough. Females were also more likely to talk about catching up on the weekends (which linked to data from this sample showing females did sleep longer on weekends) and going to bed earlier. Males were more likely to say they would nap in class, and endorsement of napping in class was also significantly associated with the presence of just one biological parent in the teen's household.

Naps may be used by this population of teens to catch up on sleep, or to augment generally inadequate sleep, especially on weekdays, but small numbers of nappers (and/or under-reporting of naps) made this hard to investigate. Teens of "other" ethnicity (African-American, Native American) tended to report significantly more nap minutes

than White or Hispanic teens. Napping did not differ across gender or household composition, though adolescents who endorsed napping in class were more likely to report nap minutes. Examining short vs. long sleepers with regard to napping, there was little difference, but these two sub-groups also reported very few naps.

As for catching up on sleep on subsequent nights, of teens who reported short sleep on one weekday or weekend night, up to 55% also reported short sleep the next night. Only 25 – 33% (weeknight-weekend night) of adolescents were able to follow a night of short sleep with a night of long sleep. This ability to catch up by sleeping longer did not vary by gender, ethnicity or household composition.

Three additional coping behaviors included altering food intake (as measured by calories or grams of fat), altering caffeine intake, and altering physical activity levels. Changes in calorie and fat intake were seen on the weekend, but not during the week. For calories, gender played an interacting role, with females in 2 of 4 sleep quartiles consuming significantly fewer calories than males, as might be expected given the significant differences between male and female caloric intake overall. These results point to gender, and also perhaps BMI, as important variables of interest in future studies concerning food consumption as a coping behavior. Sleep-calorie and sleep-fat relationships were not affected by ethnicity or household composition, however.

Changes in caffeine intake also showed up more strongly on the weekend, although differences in caffeine consumption were not statistically significant. Caffeine consumption did not vary by gender or ethnicity, although weekend caffeine intake did vary among the shortest sleepers (bottom 25%) by household composition. Teens who lived with only one parent consumed significantly more caffeine on the weekend than teens who lived with both parents.

For physical activity, although short sleep might be expected to lead to reduced activity for energy conservation, the opposite proved true in this sample. Teens who slept for shorter amounts of time engaged in physical activity for longer durations, especially on weekends. This may be due, however, to teens' physical activity being "pre-set" – for example, a sports practice or game – rather than decided upon on the spur of the moment ("I think I'll go running this morning.") The sleep-activity relationship did not vary by gender or ethnicity, although among the shortest sleepers (bottom 25%), household composition had a significant effect. Short-sleeping teens who lived with both parents engaged in a significantly longer duration of activity than teens who lived with just one parent. The reasons for this are not entirely clear and would benefit from future research, particularly a detailed household-level study focused on teen sleep and related behaviors.

❖ **What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?**

As suggested in the section above, variation in sleep duration was related to changes in calorie, fat and caffeine intake, as well as shifts in physical activity duration, especially on the weekends. For calories and fat on Sunday, the difference between average and long sleepers, with average sleepers consuming more, was statistically significant. Problems with difference in variance across sub-samples precluded a statistically significant difference between short and average sleepers on Sunday, but the data suggested a decrease across short, average and long night-before sleep categories on weekends for both calories and fat.

Caffeine intake did not differ significantly across short, average and long sleepers, but on two weekdays and two weekend days, short sleepers did consume the most caffeine, with average and long sleepers consuming less. For duration of participation in physical activity, as noted above, long sleepers spent significantly less time engaged in activity than did average or short sleepers.

❖ **How does late-evening technology use interact with teen sleep in this population of adolescents?**

Across three weeknights, teens used technology for an average of 62 to 75 minutes in the two hours before bedtime. The largest percentage used their cell phones for talking (46-71%) or texting (15 – 24%), with smaller percentages using the computer for various

reasons (email, instant messenger, Internet, MySpace) and using TV, a game console or Ipod/MP3 player. Many of the sleep variable-technology relationships showed up significantly in the directions hypothesized and supported by previous researchers, including significant negative correlations between lights-out (bedtime) and minutes of technology use, as well as sleep efficiency and minutes of technology use. Cell phone use on Sunday night led to significantly less sleep, on average, and on Weeknight 1 both technology use in general and the use of devices with potentially bright screens (computers, TVs, game systems) reduced sleep efficiency in males. However on Sunday night, computer and screen use was associated with decreased sleep onset latency, and on weeknight 2, technology use was associated with increased male sleep efficiency.

A question initially asked in the context of teen perceptions of sleep ended up being placed with technology use because teens' perceptions of females sleeping less were so often linked to their idea of females as much more frequent evening cell-phone users. Looking at sleep diary data, overall sleep differences between males and females were small. Most teens, however, said that they thought girls did sleep less than boys, both because they got up earlier to get ready for school, and because girls stayed up later talking on their cell phones. Examining the technology diary data, especially for Sunday night, lent some support to the "girls are on the cell phone more" contention, but it was not a strong, clear-cut pattern. Although "girls sleep less" was the majority view, some teens pointed out that who got more sleep probably depended more on activities and

personality than gender. In addition, a number of girls, even those who agreed that girls got up earlier, said that *they themselves* did not get up particularly early to get ready.

Strengths

This study has a unique focus on adolescent perceptions of sleep, links among sleep and food intake, and sleep and activity, and the realities of technology use by youth. Taken as a whole, it provides vital basic research that enhances the understanding of “normal” adolescent sleep as a reflection of American culture. In addition, it begins to suggest how to improve adolescent sleep, and along with it, overall adolescent health and well-being.

Expands the current literature on adolescent sleep

Although there have been many studies of adolescent sleep, most are 1) lab studies that focus on biology of sleep and/or sleep deprivation or 2) cross-sectional epidemiological studies that record hours slept and other sleep variables, often in relation to mental health or academic performance. This study not only collected sleep variables, comparable to those reported in cross-sectional studies, but also contextualized those sleep variables within teen lives, as detailed below. Although several studies have explored sleep differences across gender and ethnicity, the ethnic data often refers to African Americans, rather than Hispanics (Mexican-Americans) as in this study. Very few studies investigate the effects of activity level differences on sleep. This dissertation, however, looks at how sleep varies with gender, ethnicity, and activity level.

Two studies with adolescents (Noland et al., 2009; Owens et al., 2006) have investigated perceptions of sleep, only one of which used interviews to elicit this information. Both queried reasons for inadequate sleep and consequences of inadequate sleep, and the interview-based study also asked about sources of information about sleep. This study used a combination of interviews and questionnaires to capture perceptions of sleep in adolescents, looking at causes and consequences of inadequate sleep, sources of sleep information as well as a number of other topics, such as perceived (and actual, in my sample) sleep differences between males and females, what kind of benefits teens see as accruing from sleep, how much sleep teens think they need, and how they think about sleeping “too much.” This study also examines communication and entertainment technology use among teens. Though widely used by adolescents, these media (from cell phones to gaming systems) have only rarely been investigated for their potential effects on adolescent sleep, and never in the larger context of adolescent daily life.

Although a number of recent studies have explored the relationship between sleep and body mass index values, hormone levels and subjective feelings of hunger, my study is the first to link sleep variables with food intake and activity data collected prospectively from adolescents. Finally, there has been only a single study of how young adults cope with lack of sleep that showed napping and adjusting sleep schedules were the most effective mechanisms. The present study looks at these mechanisms, as well as adjusting food intake (specifically calories and fat), caffeine intake, and physical activity levels as

possible coping mechanisms in adolescents, and explores how all of these coping behaviors may vary by gender, ethnicity or household composition.

Expands the purview of anthropology: the “anthropology of sleep”

Another strength of this work is that it applies a comprehensive biocultural model to an area of research not often studied by anthropologists. Anthropology approaches issues of sleep, in teens and other populations, with a large toolkit for capturing both behaviors and perceptions and then comparing them. Interviews and participant observation form the basis of most anthropological studies, but they may be combined with a variety of other measures, including those designed to capture data on multiple aspects of human sleep from population history to human physiology to cultural consensus. This study only begins to capture the complexity of anthropological study of sleep. By looking at many interrelated factors affecting teen sleep, however, my study starts to illustrate how sleep is simultaneously *biologically based*, *culturally embedded*, and *environmentally shaped*, as viewed through a biocultural anthropology lense of embodiment. Visceral embodiment is seen in teens comments about their bodies driving them to go to bed when they are tired in the evenings, and waking them up at the normal “weekday” time, even on the weekends. Pragmatic embodiment is displayed by teens as they use an “I’m so tired” discourse with friends and voice strong opinions on gendered dimensions of sleep. Normative embodiment and experiential embodiment intersect in the multiple ways teens learn about sleep, often by experiencing sleep outcomes they classify for themselves as “healthy” or “not so healthy.” Normative and pragmatic embodiment, “healthy” and

“teenage” sleep, are further reinforced by early school start times and weekend activities selected by the teen or their family which drive teen wake times and lead them to the conclusion that sleeping in a healthy way means sleeping just enough to “get by” and sleeping like a teenager means being constantly tired.

In addition, teen sleep has the potential to be *medicalized/commodified*, as seen through the rise of the sleep industrial complex and the direct-to-consumer advertising of sleeping pills. Although teens are the main market for the advertising of highly caffeinated drinks, an offshoot of the “better wakefulness” pushed by the sleep industrial complex, the sleeping pill ads provide information that teens may be filing away for later, when the sleep habits they have developed in adolescence leave them sleepy in situations more important to them than high school. Finally, sleep is *negotiated*, as seen in this study through teens’ own pursuit of a balance between sleeping enough and engaging in the activities they want to, and also in the exchanges between parents and teens about when bedtime should be and why teens should sleep more.

Tracks sleep, food, activity and technology over a series of consecutive days

Sleep, as a topic of research, is very hard to isolate. Many factors, demographic, biological, cultural and environmental, affect sleep. Sleep, in turn, affects many other factors, including food intake, activity levels, and physical and mental health, to name just a few. In this study, I attempted to capture interrelationships among sleep, food, activity and technology use. Although I have been able to analyze only a small portion of this data to present here, tracking all these variables across several consecutive days

opens up many possibilities for data analysis, examining food intake, activity participation and technology use before and after nights of known sleep. In future research, I will continue to use this method of capturing consecutive days of data to aid in comprehensive exploration of teen resilience and vulnerability with regard to sleep and related behavior over the course of the school week. Much of the data that I gathered in this study was clustered at the beginning of the week, but data from Wednesday, Thursday and Friday may reveal quite a different picture of the interactions among teen sleep and food, activity and technology variables.

Limitations

Four major limitations of this study may be noted.

First, accurate food diaries are extremely difficult to collect, and rely on self-report. Even with prospective diaries across only a few days, there is no guarantee that they are reported accurately, even if participants are motivated and have the best of intentions, which is not always the case. In a similar way, sleep, activity and technology diaries are also vulnerable to the problems associated with self-report data. On a few occasions I observed students filling out past days of their diaries before handing them to me. I feel confident that naps were underestimated by students, especially short naps that occurred spontaneously, for example a teen falling asleep for 10 minutes during a movie in class. Due to social desirability, teens may have also over-estimated their sleep and underestimated their intake of junk food, especially those high in sugar and caffeine.

As few appropriate measures existed to record self-report data on food intake, physical activity and technology use for teens, I ended up developing my own measures. I did this to effectively capture a high level of detail about food, activity and technology while making sure the measures were easy to understand and complete for a 14-year-old participant. Although I did not want to over-simplify forms for these teens, I also did not want the measures to capture erroneous information because the teen did not understand them. I saw this process first-hand when I administered mental health questionnaires to my study participants. One measure, the Positive and Negative Affect Scale, lists twenty adjectives, and individuals rate how much they are feeling each descriptor at the moment, from 1 (very slightly) to 5 (extremely). Although this seemed simple enough from an adult perspective, some of my participants did not know the meaning of some of the adjectives, including distressed (is that, like, “not stressed?”) and jittery. They were also vexed by the generality of the adjectives (like, “strong” how?). This experience made me glad I had chosen to create my own diaries, despite their limitations. Future work should focus on the development of youth-appropriate measures for the collection of data on food intake, physical activity and technology use.

One piece of data that I did not collect as teens completed sleep, food, activity and technology diaries was menstrual status for females in my study. For future research, this would be important information to collect, both to identify relationships between menstrual status and sleep, food intake, or physical activity, and also to see whether

females perceive that menstruation affects their sleep or food intake. In addition, I did not make any attempt to divide teens by social group for analysis (looking, for example, at skaters vs. “popular kids” vs. goth/drama teens). These kinds of divisions are often employed in literature about teenagers, and it is possible that membership in a particular social group could affect multiple variables examined over the course of this study, including sleep, food and caffeine intake, and technology use. Teens in different social groups may also perceive their sleep differently. Therefore, future research should explore social group differences in sleep and related variables to fully capture the teen experience of sleep and sleep loss.

Directions for future anthropological research

The aim of this research was to explore sleep as a part of the lives of youth - how their lifestyles affect and are affected by it, how they think about it, and how they may change their behavior to cope when they perceive that their sleep is inadequate. This study is the first to investigate how a focus on sleep behavior illuminates the interplay of biology, culture and environment in the daily lives of youth. It is the first to ask teens to complete multiple prospective diaries, tracking their sleep, food and drink intake, physical activity participation and technology use over several consecutive days. It is one of the first to attempt to understand why teens sleep the way they do, even though many messages directed at them, and often their own experience, indicate to them that they should be

sleeping differently¹⁰. Below, I outline my top three research priorities for a future anthropology of adolescent sleep, given what I have learned about teen sleep behaviors, perceptions, and coping from this study.

Top 3 research priorities, given the results of this study

1) A household-level study of teen sleep

An especially apt area for anthropological investigation is the family/household context of sleep. This study focused almost exclusively on the teens in the context of high school. Although I learned something about how family values and priorities shape teen sleep by talking to teens, to really understand how teens learn to sleep, I need to go to the source – the household. Household research would be invaluable, because talking to parents of varying backgrounds would give me an idea of how expectations about sleep, work, activities, technology use, etc. may differ across ethnicity or other factors. Starting a study with, for example, an in-depth examination of ten families would allow me to ask more questions, and more fine-grained questions, about how teens “learn to sleep” from parents and other role models, to ultimately understand more about how sleep as a cultural behavior is transmitted from generation to generation. Such a study would also allow for the exploration of within-family “sleep cultures” – for example, if parents sleep less, do children and teens sleep less? If parents work nontraditional schedules (ie, evening shift, 3 to 11, or night shift), how do children and teens adjust their schedules

¹⁰ Although my study is more comprehensive, I would consider Owens and colleagues’ interview study with middle-school students to be the first study to explore this question (Owens JA, Stahl J, Patton A, Reddy U, and Crouch M (2006) Sleep practices, attitudes, and beliefs in inner city middle school children: a mixed-methods study. *Behav Sleep Med* 4:114-34.)

accordingly? Do parents model for children and teens that naps are beneficial, or are they seen as a “waste of time?” Finally, an in-depth family study would allow me to investigate the perceived heritability of sleep patterns, asking parents and teens if they see similarities across their family in sleep timing, in how long it takes family members to fall asleep, or if similar sleep problems are seen across generations.

2) Examining teen sleep patterns as an example of local biology

This work has applied a multi-method, integrated paradigm to the study of sleep patterns, perceptions and coping behaviors in adolescents. Examining teen life through the lens of the relationship between sleep patterns and coping behaviors has allowed me to illuminate the cultural values and concerns that combine to produce the sleep seen in this population of adolescents in this particular time and place. Now, using the data collected for this dissertation as a case study, and collecting new, comparative data, I can begin to examine sleep patterns as an example of what Lock and Kaufert (2001) term “local biology.” Worthman and Kohrt explain, “The concept of local biology has arisen from the recognition that, while the fundamentals of human biology appear universal, details of regulation and function can differ widely” (Worthman and Kohrt, 2005 p. 865).

Explained by Lock and Kaufert in terms of differences in menopause experience, local biology seems to match well with sleep. Two specific areas of *adolescent* sleep that would be a good starting point for such an investigation include 1) Examining the concept of phase delay – i.e., teens being “pushed” by their bodies to stay up later and get up later – across cultures. Although this may be a “universal” related to adolescent

development, it may also be an example of Western local biology. 2) Looking at ways in which adolescents cope with inadequate sleep across cultures. Do they preferentially chose to nap, to go to bed earlier, to adjust their food intake or activity levels, or choose some option not seen at all in this sample? The framework of local biology moves beyond questions that might be asked by psychologists or psychiatrists studying sleep, in order to explore sleep as a larger phenomenon shaped by local culture. In addition, local biology provides a structure for comparing sleep across many potential levels of difference, including, but not limited to, geographic locations and age groups.

3) Further exploration of the technology-sleep relationship in teens, using technology diaries

Having pioneered technology diaries completed in conjunction with sleep diaries in this study, I hope to continue refining this method and capturing detail on teen technology use to see how various types of technology use and sleep interrelate. Although a small literature exists on relationships between screen brightness and sleep variables, and also different types of technology use and sleep, technology is such a critical part of teen lives that more research must be done. The ever-changing nature of technology also prompts additional studies. Even the same technology, for example, a cell phone, differs radically in its functionality between a study conducted in 2003 and a study conducted in 2010. Technology and sleep is also an area of great interest for parents of teenagers. During a few exploratory interviews and one focus group I conducted with parents of teens, technology use was a topic they wanted to discuss and ask me about. Due to great shifts

in technology across less than one generation, parents of today's teens are addressing a host of questions about technology use and their teens' health and well-being, including long-term health effects of using various technologies, and what kinds of limits they as parents should be placing on teen technology use. Further research on how technology use affects teen sleep could guide development of recommendations for parents on these topics.

In addition, teens are embedded within social networks that may be displayed simply by looking at the "contacts" list on their cell phones. This presents several interesting possibilities for future research, including a social network analysis of sleep patterns across friends more generally, as introduced by Mednick and colleagues (2010) with regard to sleep and marijuana use, and Christakis and Fowler (2007) with regard to weight. A smaller-scale study might investigate the co-variation of sleep patterns across teen romantic partners.

A concept that links these technology networks back to the household study proposed above is flexible accumulation, discussed at the close of chapter 5 in the context of teen technology use. Because teens cannot combine sleep and other activities (unlike the "working" and "getting well" engaged in simultaneously by harried workers taking medication), they may stay up later, and when they do fall asleep they often keep their computer and cell phone within arm's reach all night long, and wake up to respond to new text or instant messages. A household study would allow me to observe firsthand

how parents may focus on flexibility with regard to their work hours and their specific skills, while their teenage children emulate them by engaging in flexible (always-on) communication and learning not only school-based skills but also leisure time skills. This includes participating in extracurricular activities, engaging in social interactions, and becoming proficient with, and then using, new personal technology items, all of which have the potential to interfere with sleep.

Over the course of my research, many teens asked me how they could “sleep better.” I typically gave them advice based on what I had learned from being acquainted with Dr. Richard Bootzin, an expert on the treatment of insomnia through behavioral methods. I would advise them to keep as much of a regular schedule as they could, to keep their room dark and cool, and to not exercise too close to bedtime. I told them to limit caffeine in the afternoon, and to not be on the computer or use the cell phone too close to bedtime. After a few interviews with teens, however, I realized most of this advice, especially about “regular schedules,” caffeine, and technology use was taken by teens with the best of intentions, but that it was very hard to implement in their lives. The paradox of improving sleep behavior is that it is not something you can change in isolation. Like other behaviors shaped by biology, culture and environment, “how you sleep” is internalized and embodied. Although inadequate sleep has many negative consequences in both the short and the long term, a teen cannot just say, “I’m going to sleep better today.” They may be able to change some aspects of their sleep, and improve it for a night or two, which will make a difference. On those days after adequate sleep they may

feel more alert, more focused, happier and more social. But truly altering teen sleep requires teaching teens and their parents about what constitutes adequate sleep, familiarizing them with barriers such as technology that may undermine sleep, and also teaching them effective ways to cope if teen sleep behavior is less than optimal. Unfortunately, awareness alone is not enough. To improve teen sleep in the long term also requires addressing both deeply embedded cultural values and institutional policies such as school start times. Although changing the behavior of individual teens and their families is difficult, changing these large-scale cultural and institutional realities requires a concerted effort and a commitment to encouraging long-term, incremental shifts in attitudes and behaviors. Start today. By valuing your own sleep, you encourage others – children, parents, friends, acquaintances – to value theirs. This is the shift – coupled that with widespread sleep education – that we need to improve sleep in teenagers.

APPENDIX A: COMPLETE METHODS CHART

Major research questions

- 1) *How do adolescents in this population perceive their own sleep?* This includes an examination of factors that they think affect their sleep, their perceptions of sleep need and ideas about sleeping too much and too little, and their sources of information about sleep.
- 2) What constitutes "normal sleep" in this population of adolescents?
- 3) What effect does longer or shorter sleep (as compared to average sleep length) have on total calories, fat, and caffeine consumed, and duration of physical activity on the next day in this population of adolescents?
- 4) How does late-evening technology use interact with teen sleep in this population of adolescents?
- 5) What are specific ways in which adolescents cope with inadequate sleep? Do strategies vary with regard to household composition, gender, or ethnicity?

*The starred methods in the chart below, though resulting in considerable data collected, have not been analyzed and presented in the context of this dissertation.

Method and Citation	N	Description	How often administered/used	Addresses major research questions?
Sleep diary (10 day diary, 3-day diary) Citation for general sleep diary methodology (Morin et al., 1999)	48 50 20 44	Captures night-time sleep from 3 to 10 nights: self-report	10 nights on enrollment in study, 3, 6 or 9 subsequent nights	Questions 2, 3,4 & 5
*Sleepiness scales (overview scale (Drake et al., 2003) AND *One-day scale from NIH sleep curriculum, available at: http://science.education.nih.gov/supplements/nih3/sleep/default.htm	51 50 20 44	Describes an individual's level of daytime sleepiness	1 "overview" scale at interview and 1, 2, or 3 subsequent days (always administered on the second day of diaries)	

Method and Citation	N	Description	How often administered/used	Addresses major research questions?
Semi-structured interview Researcher Developed	51	In-person interview, 30 - 60 minutes, queried about 25 domains related to sleep and participant life	1 interview per participant, about half before Time 1 diary data collection and the other half before Time 2.	All 5 questions
Participant observation		Observation and hanging out before school, during science classes, at lunch, occasionally after school. Online, on Myspace over the summer.	Typically several hours at a time, 2-3 days a week between September 2006 and April 2007. On Myspace, intermittently over the summer.	All 5 questions
Prospective food diary Researcher Developed	3 day: 6 6 day: 24 9 day: 20	Written diary asking participants to write down everything they ate or drank for a 3-day period. Names of meals and snacks (breakfast, morning snack, etc.) included as prompts	3, 6 or 9 days per participant	Questions 3 & 5

Method and Citation	N	Description	How often administered/used	Addresses major research questions?
Coke, Candy and Cellphone diary Researcher Developed	3 day: 6 6 day: 24 9 day: 20	Supplement to regular food diary asking participants to record all beverages containing caffeine, all “sugary snacks” and all technology use	3, 6 or 9 days per participant	Questions 3, 4 & 5
Physical activity diary Based on activities used in: Amherst Health and Activity Study Downloadable from: http://www.drjamessallis.sdsu.edu/measures.html	3 day: 6 6 day: 24 9 day: 20	Comprehensive list of activities; participants could check the ones they engaged in and write the number of minutes/hours spent on each activity	1 “baseline” activity diary at the interview and 3, 6 or 9 subsequent days per participant	Questions 3 & 5

Method and Citation	N	Description	How often administered/used	Research questions addressed
*Technology access and use questionnaire Researcher developed	51	List of common technologies: participants checked those they had access to and estimated the number of minutes/hours per day they used the technology on a weekday and a weekend day	Completed once at the interview	
*Technology Web Researcher developed	50	Spreadsheet that recorded who participants preferentially communicated with on varying types of technology (cell phone, Myspace, etc.)	Administered once at the beginning of Time 1 diaries	
Technology questionnaire Researcher Developed		4-question questionnaire that asked about technology items in participant's bedroom, items available after 10 pm and items sometimes or often used after 10 pm, plus a question about language spoken at home	Administered once after Time 3 data collection	Question 4

Method and Citation	N	Description	How often administered/used	Research questions addressed
<p>*Time 1 (Spring) Questionnaire</p> <p>Researcher Developed</p> <p>Smoking history questions from the 2006 Youth Risk Behavior Survey (Most recent YRBS available at: http://www.cdc.gov/HealthyYouth/yrbs/index.htm)</p>	50	<p>Asked how the participant came to this school (local HS vs. magnet participant), GPA after 1st semester, activities engaged in with school and outside of school, and current smoking/brief smoking history</p>	<p>Administered once at the beginning of Time 1 diaries</p>	
<p>*Time 2 (Summer) Questionnaire</p> <p>Researcher Developed</p>	20	<p>Asked what teens were doing over the summer (multiple choice with a few fill-in-the-blanks for more detail), usual bedtime and out-of-bed time in the summer, do they feel they get enough sleep in the summer, have they ever fallen asleep on the cell phone and if so, describe the most recent time this has happened</p>	<p>Administered for summer data collectors on the first day of Time 2 (summer) data collection; for students who only did Time 1 and 3, administered on the first day of Time 3 (fall) data collection</p>	

Method and Citation	N	Description	How often administered/used	Research Questions Addressed
Time 3 (Fall) Questionnaire Researcher Developed	44	Asked how much sleep participants think they need on weeknights/week ends, if they can catch up on sleep (and how), GPA after 1 st year in HS, two multiple choice questions about parent attitudes toward teens' bedtimes and teens financial situations	Administered once on the first day of Time 3 (Fall) data collection	Questions 1 & 5
*Four mental health questionnaires (PANAS (Watson et al., 1988), ALCES (Forman et al., 1983), BSI (Derogatis, 1993), SEQ (DuBois et al., 1996))	51	Including a measure of positive and negative affect (PANAS), the adolescent life change event scale (ALCES) to measure stress, the brief symptom inventory (BSI) to measure 7 domains of psychological problems, and the self-esteem questionnaire (SEQ) to measure self-esteem	Administered during the interview and 1, 2 or 3 subsequent times per participant	

APPENDIX B: BODY MASS INDEX AND SLEEP

Looking at the literature on sleep and food intake, most studies point to reduced sleep being associated with increased body mass index (BMI) values (Bjorvatn et al., 2007; Taheri et al., 2004). The relationship between sleep and BMI pertains only tangentially to my major question about the sleep-food relationship in this population of adolescents, but many other studies have examined these variables, so by way of comparison, I also explored them in my sample.

To examine this relationship I conducted two types of analyses. First, using all continuous variables (in this case, BMI and total sleep time) I ran partial correlations, controlling for gender, which my previous analysis showed interacting with food intake (See Chapter 7, **Tables 27 and 28**). Following this analysis, I examined total sleep time (TST) across four weeknights and two weekend nights by dividing each night's sleep into quartiles. Limits on these quartiles are described in **Table 36**.

Table 36: Sleep quartiles for weeknights and weekend nights

Quartile	On 4 weeknights, slept, on average	On 2 weekend nights, slept, on average
Bottom 25%	Less than 6 hours 47 minutes	Less than 7 hours 20 minutes
26 – 50%	6 hours 48 minutes to 7 hours 26 mins	7 hours 21 mins to 8 hours 36 mins
51 – 75%	7 hours 27 mins to 7 hours 45 mins	8 hours 37 mins to 9 hours 35 mins
76% +	7 hours 46 mins to 8 hours 51 mins	9 hours 36 mins to 12 hours

Looking at partial correlations, controlling for gender, BMI was significantly and negatively correlated by Pearson's r with total sleep time only on weekday 1 ($r(40)=-$

.367, $p=.017$), with no significant relationship shown on the other weekdays or the weekend days.

Looking at sleep quartiles, on weeknights the highest mean BMI (24.94) is associated with the lowest sleep quartile. The change in mean BMI between quartiles (total N for all quartiles =35, 11,9,8,7 for the 4 quartiles, least to most sleep, respectively) is non-significant by one-way analysis of variance (ANOVA), $F(3,31)=.163$, $p=.920$. On weekends, however, the highest mean BMI is associated with the second quartile. BMI differences across weekend quartiles (N=40 overall, 10, 11, 9, 10 for the 4 quartiles, least to most sleep) were also not significant, $F(3,36)=1.287$, $p=.294$. See **Figure 19**, below.

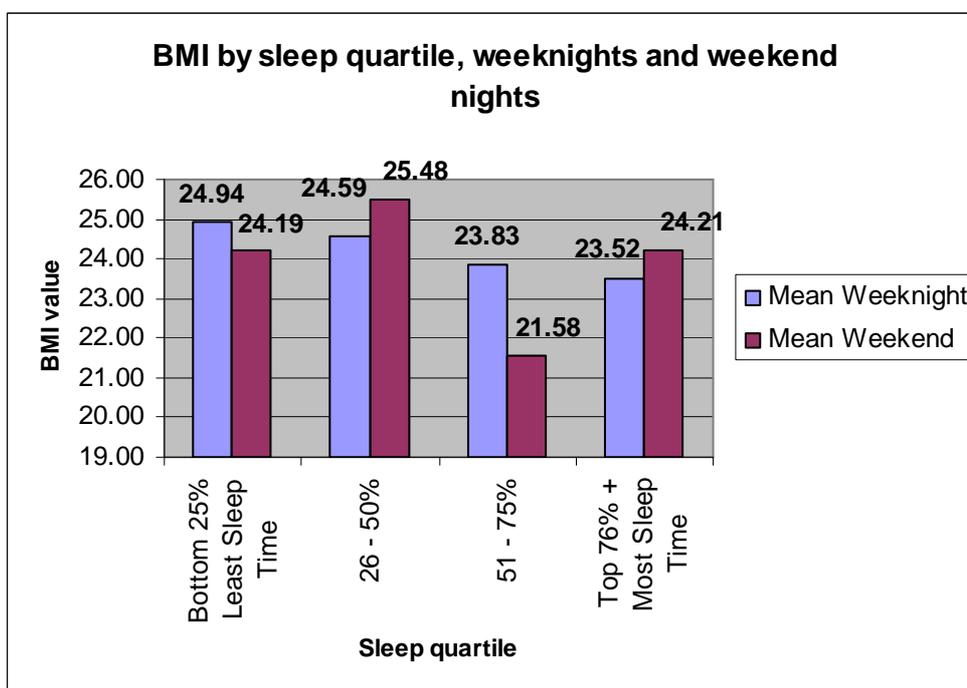


Figure 19: BMI by sleep quartile, weeknights and weekend nights

Looking at BMI by gender, for males, high BMI is consistently associated with obtaining more sleep. See **Figure 20**, below. Mean BMI associated with being in the top 25% of sleep time for males was 28.37 (N=3) on weekdays, although this BMI value was not significantly different by one-way ANOVA ($F(3,12)=.649$, $p=.598$) from the BMI values associated with shorter sleep (Bottom 25%, mean BMI=24.45, N=3; 26-50%, BMI=26.47, N=3; 51-75%, BMI = 24.12, N=7). On weekends, mean BMI associated with being in the top 25% of sleep time was 29.33 (N=2). Differences in mean BMI across sleep quartiles were significant by one-way ANOVA on weekends for males, $F(3,16)=3.940$, $p=.028$. T-test comparisons showed that the bottom 25% (mean BMI=22.02, N=6) differed significantly from the second quartile (mean BMI=26.81, N=8), $t(9)=-.2.615$, $p=.029$, and the top 25% (mean BMI=29.33, N=2), $t(6)=-4.772$, $p=.003$. The third quartile (mean BMI = 21.23, N=4) also showed a marginally significant difference from the BMI associated with the top 25% of sleep time, $t(4)= -2.632$, $p=.058$.

For females on weekdays, teens who slept least showed the highest mean BMI values (Bottom 25% mean BMI=25.12, N=8) but BMI does not differ significantly across weekday sleep quartiles, $F(3,15)=1.298$, $p=.312$. For weekdays among females, total N=19 (second quartile, BMI=23.65, N=6; third quartile, BMI = 21.85, N=1; top 25%, BMI=19.89, N=4). On weekends, sleeping less is also associated with the higher female BMI (Bottom 25% of sleep time, mean BMI = 27.44, N=4) but differences in mean BMI across quartiles are not significantly different by one-way ANOVA, $F(3,16)=1.480$,

$p=.258$. Total weekend female $N=20$ (second quartile, $BMI=21.93$, $N=3$; third quartile, $BMI=21.85$, $N=5$, top 25%, $BMI=22.93$, $N=8$).

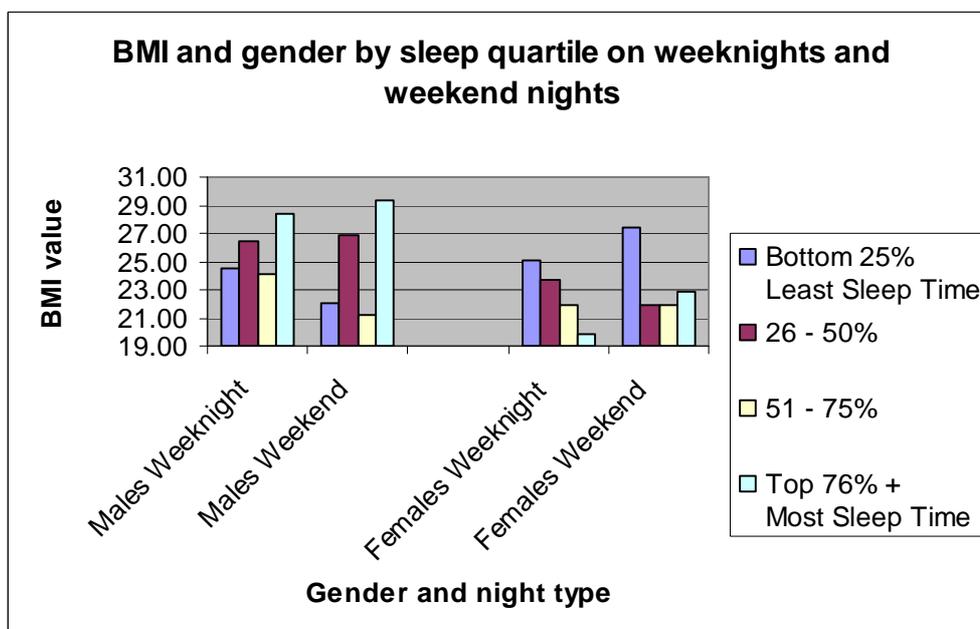


Figure 20: BMI and gender by sleep quartile on weeknights and weekend nights

Examining the BMI-sleep-ethnicity relationship among White teens, BMI does not differ significantly across sleep quartiles as measured by one-way ANOVA, $F(3,13)=.512$, $p=.681$. See **Figure 21**, below. For White adolescents, total weeknight $N=17$ (Bottom 25% mean $BMI=20.61$, $N=4$; second quartile, $BMI=24.78$, $N=4$, third quartile, $BMI=23.64$, $N=4$ and top 25% $BMI=22.62$, $N=5$). On weekends, BMI also did differ significantly across sleep quartiles, $F(3,16)=1.396$, $p=.280$. Total weekend N for White adolescents = 20 (Bottom 25% mean $BMI=21.58$; second quartile $BMI=26.16$, $N=6$; third quartile $BMI=21.39$, $N=6$ and top 25% $BMI=23.06$, $N=4$).

For Hispanic teens, although BMI is highest among the group with the least sleep (Bottom 25% mean BMI=26.82, N=5), differences in BMI values are not significantly different across sleep quartiles, $F(3,10)=1.162$, $p=.372$. For Hispanic teens on weeknights, total $N=14$ (second quartile mean BMI=25.96, $N=4$, third quartile BMI=24.03, $N=4$ and top 25% BMI=20.00, $N=1$). On weekends, Hispanic adolescents with the shortest sleep times show the highest mean BMI (Bottom 25% mean BMI=25.38, $N=5$) though again, BMI differences across sleep quartiles are not statistically significant by one-way ANOVA, $F(3,12)=.466$, $p=.711$. For Hispanic teens on weekend nights, total $N=16$ (second quartile mean BMI=23.54, $N=4$; third quartile BMI=21.95, $N=3$, top 25% BMI=25.00, $N=4$).

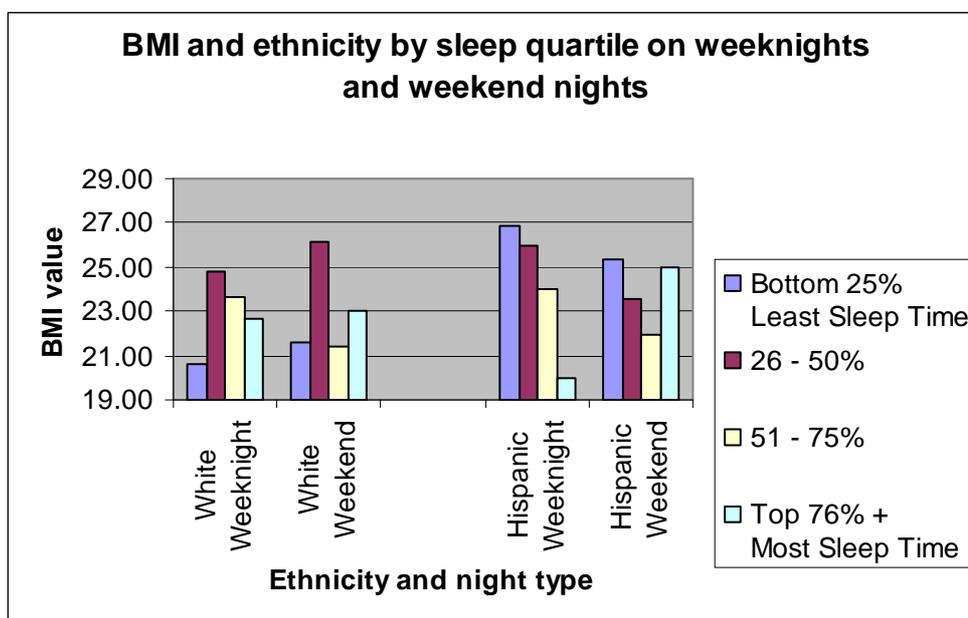


Figure 21: BMI and ethnicity by sleep quartile on weeknights and weekend nights

Looking at overall mean BMI values across sleep quartiles, and among female and Hispanic subgroups, shorter sleep (being in the bottom 25% of sleep time) tends to be associated with higher mean BMI values. However, this is not true for males or White teens. For all comparisons, rising amounts of sleep are not associated with drops in mean BMI, as current literature suggests should be the case. Small sample sizes and unequal variance across groups complicate the findings from this research, but these results do suggest that future studies examining the sleep-BMI relationship should consider gender and ethnicity as potentially salient modifiers of the relationship.

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