SLEEP HABITS AND CAFFEINE USE IN COLLEGE STUDENTS: A CONVENIENCE SAMPLE

A thesis submitted to the Kent State University College and Graduate School of Education, Health, and Human Services in partial fulfillment of the requirements for the degree of Master of Science

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SLEEP HABITS AND CAFFEINE USE IN COLLEGE STUDENTS: A CONVENIENCE SAMPLE (111 pp)

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The purpose of this study was to provide a description of the caffeine intake and sleeping habits of undergraduate college students and differences in caffeine intake with respect to gender, type of consumer (non-caffeine consumer or low, moderate, high and very high caffeine consumer), and location of residence. An anonymous, online self-administered Caffeine Consumption and Sleep Questionnaire was completed by currently registered undergraduate college students ages 18-24 (n=2407) with full-time academic status, providing total milligrams of caffeine consumed as well as total hours of sleep per participant. Means, standard deviations, and a 2X5X8 Factorial ANOVA were used to determine differences in sleep and caffeine consumption in respect to residence, caffeine consumer status, and residence location. Post hoc analysis was performed for all significant analyses. There was no significant difference between genders in caffeine consumption ($p =0.956$), and location of residence did not impact caffeine intake ($p=0.140$). However, there was a significant difference with sleep and consumer status ($p=0.001$), with high caffeine consumers sleeping less than low caffeine consumers. These findings suggest that better education for students is needed on both sleep hygiene and the drawbacks of caffeine consumption to improve student well-being and prevent health issues in the future.
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CHAPTER I

INTRODUCTION

Humans spend about one third of their lifetime asleep (Reinoso-Suarez, de Andrés, & Garzón, 2011). It is still debatable about how sleep works, but it is essential to all forms of life and their survival. In general, adults need about seven to eight hours of sleep per day (Chaput, Després, Bouchard, & Tremblay, 2008). Some broader recommendations for college students specifically state that six to nine hours of sleep per day is optimal for proper functioning; at anything less than seven hours per day, individuals are at risk for an increased mortality as well as weight gain (Chaput, Després, Bouchard, & Tremblay, 2008; Hublin, Partinen, Koskenvuo, & Kaprio, 2007).

College students often have restricted and irregular sleep (Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997). From 7.5 hours of sleep per night in 1969 to 6.5 hours in 1989, this population continues to lose sleep (Brown, Buboltz, & Sopher, 2002). College students have poor sleep quality and sleep satisfaction, increasingly worsened by academic year in school (Eliasson, Lettieri, & Eliasson, 2010; Liguori, Schuna, & Mozumdar, 2011). Sleep quality can also be associated with academic progress, illness, social activities, stress, and living conditions (Lund, Reider, Whiting, & Prichard, 2010; Veldi, Aluoja, & Vasar, 2005). Relying on the consumption of caffeine as well as alcohol consistently equates to poor sleep hygiene (Brown, Buboltz, & Sopher, 2002; Lund, Reider, Whiting, & Prichard, 2010; Sweileh, Ali, Sawalha, Abu-
Taha, Zyoud, & Al-Jabi, 2011). Insufficient sleep time and the behavioral consequences that result are the contributing factors in poor academic performance in college students (Eliasson, Lettieri, & Eliasson, 2010; Gaultney, 2010).

Caffeine is the world’s most popular drug (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). Caffeine is metabolized quickly because of its water solubility, and is transported amongst all body tissues and secretions equally, from breastmilk to saliva and semen (Chambers, 2009; James, 1997; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). The concentrations of caffeine in the body rely on a multitude of factors and the drug’s half-life varies from two to up to nine and a half hours (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Weinberg & Bealer, 2001).

The consumption of caffeine to reap its benefits or suffer its consequences depends on the task at hand and the dose consumed (James, 1997; Schellack, 2012). Benefits of caffeine usage include increases in athletic performance, work, cognitive functioning, and weight loss (Doan, 2006; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001; Wilson & Temple, 2004). However, caffeine offers some substantial dangers and it is still debatable if caffeine is safe long-term. Heart function, bone health, reproduction, cancer, and mood are all compromised with caffeine intake (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). High
consumption of caffeine also has detrimental effects, from dependence and withdrawal to psychological disorders such as caffeinism and even death (American Psychiatric Association, 2000; James, 1997).

Today, American adults consume an average of 200 mg caffeine daily (Norton, Lazev, & Sullivan, 2011; Shohet & Landrum, 2001; Weinberg & Bealer, 2001). However, age is a large factor determining caffeine use, seen by both the marketing targeted to young adults as well as the late night lifestyle seen in this population (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). A study by Norton et al. found that 98% of college students had ever consumed caffeine, making it the most popular substance on campuses with an average of 1106.23-1698.02 mg per week, increasing with year in school (Norton, Lazev, & Sullivan, 2011). One study by Shohet and Landrum found that not one student surveyed (n=691) was caffeine free (2001). Adding to this the removal of parents from a teen’s life, sleep as well as caffeine intake may have no moderation whatsoever in this population.

Statement of the Problem

College students have been studied in relation to both sleep data and caffeine intakes, but never before has a study tried to integrate both of these crucial tenets of collegiate life. In this population, sleep is extremely limited and may harm health. A study from Sweileh et al. found students to have an average of 6.4 hours of sleep per night (2011). Varying class times, work, projects, family, and social obligations cut into sleep time (Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997).
To combat this lack of sleep, high caffeine intakes are seen in this group. One study by Shohet and Landrum found that not one student surveyed (n=691) was caffeine free (2001). In another study by Norton, Lasev, and Sullivan, while 22% of students currently smoke cigarettes, and 50% have had at least one alcoholic drink in the past month, 89% consumed caffeine in the past month (2011). Students consume these products out of curiosity, for energy, and to boost performance. These beverages are often mixed with alcohol at parties, masking the effects of alcohol and how much one has consumed (Arria, Caldeira, Kasperski, Vincent, Griffiths, & O'Grady, 2011; Attila & Cakir, 2011).

Purpose Statement

The purpose of this comparative study is to determine if there are differences in caffeine consumption in gender as well as residence status and sleep differences in high caffeine consumers versus low caffeine consumers at a public, Midwestern university.

Hypothesis

There will be a difference between genders, residence status, and sleep with caffeine consumption, with on-campus students expected to consume more caffeine and high caffeine consumers expected to sleep less than their peers.

Operational Definitions

- Students: any male or female undergraduate student that is in the Kent State University campus system. Must be currently enrolled full time (12 credits or more/semester), be between the ages of 18-24, and not be a parent.
- Off-campus: any location of residence outside of university dormitories.
- Very high caffeine consumer: an individual that has consumed 1001 + mg of caffeine in the past day (Loke, 1988).
- High caffeine consumer: an individual that has consumed 301-1000 mg of caffeine in the past day (Huntley & Juliano, 2011; Johnson-Greene, Fatis, & Shawchuck, 1988; Loke, 1988; Shohet & Landrum, 2001).
- Moderate caffeine consumer: an individual that has consumed between 101-300 mg of caffeine in the past day (Huntley & Juliano, 2011; Norton, Lazev, & Sullivan, 2011).
- Low caffeine consumer: an individual that has consumed 21-100 mg of caffeine in the past day (Huntley & Juliano, 2011; Loke, 1988; Shohet & Landrum, 2001).
- Non-caffeine consumer: an individual that has consumed 0-20 mg of caffeine in the past day (Huntley & Juliano, 2011).
CHAPTER II

REVIEW OF LITERATURE

The Importance and Function of Sleep

Sleep is a behavioral state characterized by suspended consciousness leading to reduced perception, rest, and a lack of movement (Pollak, Thorpy, & Yager, 2010). Sleep differs from a coma or hibernation in mammals in that it is rapidly reversible. Other behavioral components that help to better define sleep include increased arousal thresholds, a circadian rhythm and regulation of a 24-hour pattern, specific posture and place preferences, and homeostatic regulation of lost sleep (Lockley & Foster, 2012). Humans spend about one third of their lifetime asleep, and there are multiple theories that attempt to explain this (Reinoso-Suarez, de Andrés, & Garzón, 2011). The Restorative Theory hypothesizes that sleep restores the cellular components of the body (Cirelli & Tononi, 2008). Many central nervous system genes are expressed differently, cells are repaired, and transcripts for both synaptic potentiation and fat metabolism are expressed at higher levels all during sleep (Cirelli & Tononi, 2008; Lockley & Foster, 2012; Pollak, Thorpy, & Yager, 2010). The theory of energy conservation discusses the idea that sleep is an evolutionary measure to reduce energy demands. Caloric demand and body temperature decrease during sleep. The energy conserved via sleep is quite minimal, up to ten percent in some species, so this theory lacks a lot of support (Division of Sleep Medicine at Harvard Medical School, 2007; Lockley & Foster, 2012). The theory of brain efficiency, or of neural function, focuses on cognitive impairment upon sleep...
deprivation and the consolidation of new neural networks (Cirelli & Tononi, 2008; Lockley & Foster, 2012). A related, but differing Cleansing Theory revolves around the idea that sleep cleanses out unwanted memories and consolidates the ones that need to be kept (Pollak, Thorpy & Yager, 2010). This one believes that REM (rapid-eye movement) sleep and dreaming are also factors to memory retention. The Circadian Theory strongly believes in sleep existing to maintain circadian rhythms. This impacts both homeostasis and a normal sleep-wake pattern for optimal human function (Pollak, Thorpy, & Yager, 2010). Lastly, several smaller and more innovative theories try to pinpoint specific needs as a result of sleep. The universal function of sleep hypothesizes that sleep evolved to serve all organisms for the same purposes (Cirelli & Tononi, 2008). There is also a theory that suggests one main function that sleep is the basis for, known as the core function of sleep (Cirelli & Tononi, 2008). This suggests sleep is a function that impacts many processes and mechanisms and that there are many ways to achieve this goal across different species and phenotypes (Cirelli & Tononi, 2008). It is still unclear the precise rationale behind sleep, but it is essential to all living organisms and their survival.

**Sleep Requirements for College Students**

As college students are older teenagers becoming young adults, nine hours of sleep per night is the initial goal. For a student that has moved on into adulthood, seven to eight hours of sleep is recommended; this is the recommendation for adults as well (Liguori, Schuna, & Mozumdar, 2011; Pilcher, Ginter, & Sadowsky, 1997; Sutton, 2005). Other recommendations suggest a range of seven to nine hours per day for college
students (Lockley & Foster, 2012; Reinoso-Suarez, de Andrés, & Garzón, 2011). Some broader recommendations state that six to nine hours of sleep per day is optimal for proper functioning; at anything less than seven hours per day, individuals are at risk for increased mortality as well as weight gain (Chaput, Després, Bouchard, & Tremblay, 2008; Hublin, Partinen, Koskenuvo, & Kaprio, 2007).

Documented sleep in this population historically has been declining. In 1969, the average sleep duration was 7.5 hours per night, then 6.5 hours in 1989; in 2010 the average fell to about 6.2-6.4 hours of sleep (Brown, Buboltz, & Sopher, 2002; Sweileh, Ali, Sawalha, Abu-Taha, Zyoud, & Al-Jabi, 2011). Irrespective of the recommendations, the college student population is not getting the adequate sleep needed and this leaves them vulnerable to a multitude of consequences.

**The Types of Sleep**

All mammalian sleep follows circadian rhythms, or biological processes that repeat approximately every 24 hours (Stickgold & Walker, 2009). While closer to 25 hours in nature, circadian rhythms are regulated by the suprachiasmatic nucleus (SCN) in the brain and impact temperature regulation, hormone production, cardiac and lung functions, among a wide variety of other body processes in addition to sleep (Cappuccio, Miller, & Lockley, 2010). The natural rhythm for humans has been altered due to environmental factors, such as artificial light; sunlight resets the SCN, so the circadian rhythms follow the 24 hour pattern of the sun versus the innate 25 hour biological cycle (Sutton, 2005). Circadian rhythms can be disrupted or modified over time depending on patterns of sleep and wakefulness, such as napping, jet lag and shift work (Cappuccio,
Miller, & Lockley, 2010; Stickgold & Walker, 2009; Sutton, 2005).

**NREM and REM Sleep**

Within the cyclic nature of circadian rhythms, sleep is composed of its own cycle known as the sleep-wakefulness cycle (SWC) (Reinoso-Suarez, de Andrés, & Garzón, 2011). The actual time duration of the sleep cycle varies across the animal kingdom and is based largely in part on body volume. For humans, a sleep cycle can range from 85-115 minutes, with the first cycle being the shortest and having the longest period of deep sleep. Age and health, among other factors, can influence sleep cycle length as well (Craighead, Nemeroff, & NetLibrary, 2001; Sutton, 2005). There are two categories of sleep; sleep is either quiet or slow wave sleep (SWS), also known as NREM (non rapid-eye movement) sleep; or paradoxical sleep, better known as REM (rapid-eye movement) sleep (Reinoso-Suarez, de Andrés, & Garzón, 2011). NREM sleep has no muscle paralysis, less active brain waves, steadier vitals and no rapid eye movements. NREM sleep incorporates the deepest sleep, takes up the majority of the total sleep time and includes the first four stages of sleep (Badr, 2012; Craighead, Nemeroff, & NetLibrary, 2001). REM sleep, on the other hand, is characterized by loss of tone in the muscles, more active brain waves, variable vital signs, and rapid eye movements. (Craighead, Nemeroff, & NetLibrary, 2001). REM sleep takes up about 25% of the total sleep time of an adult and is the fifth stage of sleep (Pollak, Thorpy, & Yager, 2010).

In the SWC, starting with NREM sleep, some researchers include stage 0, or wakefulness, which is characterized by open eyes and activity. Even while resting with eyes closed, an individual still has brain activity like that of a normally alert person
Stage 1 lasts for five minutes, has theta brain waves and is a very light sleep, or dozing; this bridges the gap between wakefulness and sleep (Pollak, Thorpy, & Yager, 2010; Reinoso-Suarez, de Andrés, & Garzón, 2011). In this stage, an individual can be awakened easily and has reduced muscle and eye movements (Reinoso-Suarez, de Andrés, & Garzón, 2011). If awakened during this stage, an individual would only remember fragments. Some individuals also experience hypnic myclonia, or movements similar to the startle reflex (Sutton, 2005). Stage 2 of sleep lasts up to 20 minutes, has spindle or k-complex brain waves and is a light sleep (Reinoso-Suarez, de Andrés, & Garzón, 2011; Vaughans, 2011). The sleep spindles occur in bursts and all eye movements stop (Sutton, 2005). Stage 3 of sleep can last up to 30 minutes and delta waves begin to appear (Sutton, 2005; Vaughans, 2011). Stages 3 and 4 are considered deep sleep with no muscle movement or eye activity; in stage 4 of sleep, the delta waves are larger and sleep terrors or sleepwalking may occur (Pollak, Thorpy, & Yager, 2010; Reinoso-Suarez, de Andrés, & Garzón, 2011; Sutton, 2005). Stage 4 is the deepest stage of sleep and is often classified as an extension of Stage 3. In addition, it is extremely difficult to awaken an individual once they have reached this stage of sleep. From stage 4, one then progresses back through stages 3 and 2. It is then that REM sleep is reached (Vaughans, 2011).

REM sleep, or stage 5 of sleep, tends to increase in length as the night progresses. The rapid eye movements occur in bursts, and often muscle twitches coincide with these (Reinoso-Suarez, de Andrés, & Garzón, 2011). REM sleep is the most restorative sleep, yet varies greatly throughout the life cycle. Infants have 50% of their total sleep in the
REM form, versus 25% at childhood, which remains steady then declines further after the age of 60 (Badr, 2012; Craighead, Nemeroff, & NetLibrary, 2001). Once REM has ended, an individual progresses from stage 2 to stage 4 of sleep, then back down to 2, and REM occurs again (Vaughans, 2011).

**Continuous and Discontinuous Sleep**

Sleep can be described in terms of quality. Continuous sleep, also known as monophasic sleep, refers to sleeping in one chunk in a 24 hour period. This is the preferred way to get optimal sleep and involves no break in slumber. This is the pattern of society today, in particular, adults (National Sleep Foundation, 2011). On the other hand, there is discontinuous sleep. Also known as biphatic sleep, polyphasic sleep or sleep fragmentation, this refers to sleeping in sections. This can occur due to sleep disorders, age, or environment. Newborns, toddlers, college students, night shift workers, and the elderly tend to follow this sleeping pattern, with one shorter period of sleep at night and a nap or several during the day (National Sleep Foundation, 2011; Pollak, Thorpy, & Yager, 2010; Zulley & Bailer, 1988). Before the Industrial Revolution, a segmented sleep pattern was quite common, as a lack of light after sunset limited the activities one could do. The time in between both sets of sleep was often looked at as a time of reflection or for intimacy across many cultures (Etkich, 2001). Daytime sleepiness resulting in discontinuous sleep is a significant problem for college students today, however (Veldi, Aluoja, & Vasar, 2005).

**Naps.** Naps are defined as a brief sleep episode outside the main sleep period. They can vary in length, from minutes to several hours. Often, when a nap is taken, the
overnight sleep period is shortened (Pollak, Thorpy, & Yager, 2010; Stickgold & Walker, 2009). Naps serve to counteract sleepiness or fatigue. An hour-long nap can have four times as much deep sleep versus a half-hour nap, giving more slow-wave sleep and effectively diminishing burnout (Sutton, 2005).

A nap differs from a siesta in that a siesta is a cultural phenomenon in Latin American and Spanish countries, and is also taken specifically at the point in the day with the most sleepiness – from two to four in the afternoon. As a result, a later bedtime is a widespread practice (Pollak, Thorpy, & Yager, 2010). In highly industrial countries, naps are currently being investigated as a quick and inexpensive way to decrease sleep-related accidents, improve quality of work, and increase optimal function by eliminating fatigue (Stickgold & Walker, 2009).

Naps can also be a symptom of a sleep disorder, such as excessive daytime sleepiness, obstructive sleep apnea syndrome, and narcolepsy (Pollak, Thorpy, & Yager, 2010). Excessive daytime sleepiness is often a symptom of hypersomnia, or sleeping up to 12 hours per night in addition to naps. These naps are not refreshing and do not improve performance (American Psychiatric Association, 2000). Obstructive sleep apnea syndrome includes loud snoring, breathing pauses during sleep, and also excessive daytime sleepiness. Narcolepsy, on the other hand, is characterized by irresistible attacks of refreshing sleep and REM sleep between sleep and wakefulness (American Psychiatric Association, 2000). In narcoleptics, naps go into REM sleep and are pleasant; in contrast, with sleep apnea patients, naps cause headaches and accelerate fatigue (Pollak, Thorpy, & Yager, 2010). In these cases, naps are a coping mechanism for the body to make up
for poor or inadequate nocturnal sleep. Overall, nap quality varies from individual to individual, depending on the amount of time spent napping and the presence or absence of sleep disorders (Pollak, Thorpy, & Yager, 2010).

**Barriers to Sleep**

An occasional night with difficulty sleeping is common, but 74% of American adults experience such a problem a few nights per week or more (National Sleep Foundation, 2011). A myriad of factors can make sleep difficult or even impossible; the top cause of self-reported sleep loss is due to worrying or thinking (Cappuccio, Miller, & Lockley, 2010). Many sleep disorders may also bar normal sleep, but often a specialist is needed to combat the complexity and extreme variance of these disorders and to treat the underlying causes (American Psychiatric Association, 2000). If caught quickly enough, sleep difficulties can be reversed instead of progressing towards sleep deprivation and its poor impact on health (Sutton, 2005).

**Stress as a Barrier to Sleep**

Stress is unavoidable and a leading cause of insomnia, or an inability to sleep despite being tired, waking up too early, or a light, un-restful sleep (Sutton, 2005). This stress can also be described further as seven different types of “worry” - concerns about the future, family concerns, feelings of loneliness, money concerns, relationship concerns, work concerns, and safety concerns (Cappuccio, Miller, & Lockley, 2010). Due to the connection with the types of “worry” to wife/mother roles, women have overall less quality sleep (Cappuccio, Miller, & Lockley, 2010). Stress is a top contributor to sleep loss in college students, with over 35% having “worries about the
future” or “racing thoughts” at bedtime (Lund, Reider, Whiting, & Prichard, 2010). In addition, 39% of students cite academic stress and 25% cite emotional stress as the main factor interfering with their sleep (Lund, Reider, Whiting, & Prichard, 2010). Stress due to work or projects is also common (Pollak, Thorpy, & Yager, 2010). Grief, another form of stress, can impact sleep for a short period of time or may develop into a long term problem (Pollak, Thorpy, & Yager, 2010). The impact stress has on sleep can vary widely.

**Alcohol as a Barrier to Sleep**

Several substances heavily impede sleep. While alcohol is a depressant, it can not only disrupt the second half of the sleep period, but it can induce sleep disorders over time, such as sleep apnea (Sutton, 2005). Even if consumed six hours before bedtime, sleep is fragmented (Barkoukis, Matheson, Ferber, & Doghramji, 2012; Sutton, 2005). With continued pre-bedtime consumption, these disruptive effects will increase while the sleep-inducing effects will decrease. This effect is more noticeable in alcoholics, who have an additional set of sleep disturbances, including an increased time to fall asleep, daytime fatigue due to a decrease in sleep quality, and frequent awakenings (Sutton, 2005). Even if sobriety were obtained in these individuals, sleep disturbances could last up to 12 months thereafter (Barkoukis, Matheson, Ferber, & Doghramji, 2012).

**Caffeine as a Barrier to Sleep**

Caffeine can cause sleep disturbances as well within the sleep-wake cycle. If caffeine is consumed into mid-afternoon, it continues to act as an anti-fatigue agent as well as a diuretic throughout the late evening (Verster, Pandi-Perumal, & Streiner, 2008).
It can have an effect anywhere from one to three hours consumed before bedtime to up to 12 hours earlier, depending on the individual (Sutton, 2005; Verster, Pandi-Perumal, & Streiner, 2008). In those individuals vulnerable to stress, disturbed sleep is even more probable (Barkoukis, Matheson, Ferber, & Doghramji, 2012). In daily consumers, there is habituation and the overall effects on sleep vary greatly from person to person (Barkoukis, Matheson, Ferber, & Doghramji, 2012; Verster, Pandi-Perumal, & Streiner, 2008).

**Drugs as a Barrier to Sleep**

Some medications, like some cold and allergy medicines, anti-hypertensives, beta blockers, oral contraceptives, and pain relievers may induce insomnia in individuals; often these drugs contain the stimulant caffeine to help speed up the medicine’s delivery or to combat a drowsy side effect (Sutton, 2005). Other drugs, like the antidepressant class’s (Table 1) selective serotonin reuptake inhibitors (SSRIs), selective serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCAs), and irreversible and reversible selective monoamine oxidase inhibitors (MAOIs), suppress REM sleep as a side effect of their mood-stabilizing properties (Craighead, Nemeroff, & NetLibrary, 2001; Winokur & Demartinis, 2012). Antidepressants in particular interfere with neurotransmitters that regulate sleep-wakefulness; norepinephrine and serotonin repress REM sleep and acetylcholine initiates REM sleep (Winokur & Demartinis, 2012). With little to no REM sleep, REM latency is shortened and non-REM sleep increases, resulting in less restful sleep (Craighead, Nemeroff, & NetLibrary, 2001).
Table 1. *Antidepressants That Negatively Affect Sleep*

<table>
<thead>
<tr>
<th>Drug class/medication</th>
<th>Chemical action</th>
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<th>Common drugs on the market</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSRI</td>
<td>Serotonin reuptake inhibition</td>
<td>Suppressed REM, increased REM latency</td>
<td>Celexa, Lexapro, Luvox, Paxil, Pexeva, Prozac, Sarafem, Zoloft</td>
</tr>
<tr>
<td>Selective SNRI</td>
<td>Serotonin and norepinephrine reuptake inhibition</td>
<td>Suppressed REM, increased REM latency</td>
<td>Cymbalta, Effexor, Pristiq</td>
</tr>
<tr>
<td>TCA</td>
<td>Serotonin and norepinephrine reuptake inhibitors</td>
<td>Decreased sleep latency as well as suppressed REM</td>
<td>Anafranil, Aventyl, Elavil, Ludiomil, Norpramin, Pamelor, Sinequan, Surmontil, Tofranil, Vivactil</td>
</tr>
<tr>
<td>MAOI</td>
<td>Increase norepinephrine, dopamine and serotonin concentrations by decreasing their metabolism</td>
<td>Prolong sleep onset and increase nocturnal awakenings, suppressed REM</td>
<td>Marplan, Nardil, Parnate, Phenelzine, Selegine, Tranylcyromine</td>
</tr>
</tbody>
</table>

(National Institute of Mental Health, 2011; Winokur & Demartinis, 2012).

**Living Arrangements as a Barrier to Sleep**

Living arrangements have a huge impact on the ability to sleep or lack thereof.

Having a roommate or several, sharing a bed with a spouse, living in a noisy dorm or apartment, environmental noises, temperature, comfort of the bed and even the clock in the room can all make sleep impossible (Barkoukis, Matheson, Ferber, & Doghramji, 2012; Cappuccio, Miller, & Lockley, 2010; Pollak, Thorpy, & Yager, 2010; Sutton, 2005). Roommates that snore, sleepwalk, or sleeptalk can also hurt the sleep of those around them by constantly waking them and depriving them of deeper sleep as well as REM sleep. In the collegiate population, social surroundings are often a large reason why students do not sleep at all; over half surveyed stayed awake simply to socialize (Liguori, Schuna, & Mozumdar, 2011), and over half surveyed in another study stayed up late at night to study and do assignments (Eliasson, Lettieri, & Eliasson, 2010).
Travel as a Barrier to Sleep

Jet lag, or the slow adjustment of the circadian rhythm to a new time zone while traveling, is another barrier to sleep. While short-lived, practicing good sleep hygiene can minimize its effects (Sutton, 2005).

Work as a Barrier to Sleep

Perhaps the largest barrier to sleep in the social setting is shift work, or a shift not beginning in the morning (Sutton, 2005). The circadian rhythm cannot completely adjust to a reverse light-dark schedule even with time; sleep in these individuals is often disturbed, missing REM sleep, and is not refreshing (Cappuccio, Miller, & Lockley, 2010; Verster, Pandi-Perumal, & Streiner, 2008). There are several sleeping patterns these individuals may follow, but they cannot often utilize naps to try to meet their sleep needs, unlike some of the newer companies working with naps to lessen accident risks and improve productivity (Cappuccio, Miller, & Lockley, 2010; Stickgold & Walker, 2009; Sutton, 2005). Current coping mechanisms for shift work involve either segmented sleep when possible, bright light therapy, or the use of caffeine; if not dealt with properly, whether by altering sleep surroundings, bedtime rituals, or the schedule of work itself, Shift-Work Disorder may result (Cappuccio, Miller, & Lockley, 2010; Sutton, 2005).

Consequences of Sleep Deprivation

Sleep deprivation is detrimental to the body in many ways. When going without sleep, “sleep debt” accumulates; this must be replenished at whatever cost, usually at the expense of a person’s health (Lockley & Foster, 2012). Changes in mood and attentiveness can begin after just 36 hours and are most noticeable during typical sleep
times, especially at four to six in the morning (Pollak, Thorpy, & Yager, 2010).
Performance, awareness, and attention to detail are severely diminished (Cappuccio,
Miller, & Lockley, 2010; Sutton, 2005). Physical manifestations of sleep deprivation
may be present as well, including muscle weakness, tremors, and a lack of coordination
(Pollak, Thorpy, & Yager, 2010). Overall, chronic sleep deprivation’s effects are just as
damaging as those of acute sleep loss. Two weeks with less than six hours of sleep per
night can make an individual’s performance equivalent to that to someone who has
stayed up for 24 hours straight; this occurs in half the time in someone who has slept four
hours a night (Lockley & Foster, 2012). Sleep deprivation can be reversed, especially
with acute cases. Individuals getting four to five hours of sleep a night for one week
would require two full nights of sleep to recover (Sutton, 2005). This would allow for
REM rebound, or the increase in the REM stage of sleep, to occur to replenish lost sleep.
The REM cycle will then decrease in length once the body returns to a normal circadian
pattern with regular amounts of sleep (Pollak, Thorpy, & Yager, 2010). Chronic sleep
deprivation has relationships with mortality and irreversible disease states; proper sleep
hygiene can prevent sleep deprivation from reaching this point (Lockley & Foster, 2012).

**The Hormonal Effects of the Sleep Cycle**

Hormones, like other bodily functions such as heart rate, can often be tied to
circadian rhythms (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012). Sleep
deprivation also overactivates the hypothalamic-pituitary-adrenal (HPA) axis (Lund,
Cortisol in normal states rises right before waking up for the day even if not asleep and
can be elevated even more if waking up during the night (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). Meals, often breakfast, as the first stimuli of the day, can also influence cortisol; this would be off if sleeping patterns are as well (Stickgold & Walker, 2009). With sleep deprivation, cortisol elevation occurs later in the evening when it should be at its lowest (Pandi-Perumal, Cardinali, & Chrousos, 2007; Stickgold & Walker, 2009). Melatonin levels, on the other hand, remain stable with sleep but are more suppressed if lights are low (Lockley & Foster, 2012). Levels will peak later if bright light is applied late in the day, or advance earlier if bright light is applied in the early morning hours (Cappuccio, Miller, & Lockley, 2010; Stickgold & Walker, 2009).

Some hormones can also depend on sleep itself, such as growth hormone (GH) and thyroid-stimulating hormone (TSH). GH is secreted during the earlier stages of sleep, whereas TSH slightly peaks right before sleep (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012). In men, 50-70% of GH is secreted during this time, so growth and repair are severely limited in cases of sleep deprivation (Stickgold & Walker, 2009). With sleep deprivation, TSH will have a much higher peak (Lockley & Foster, 2012; Stickgold & Walker, 2009). Also, prolactin is secreted after sleep onset and peaks in the middle of the sleep period. Brief awakenings will occur during sleep if it is delayed by sleep deprivation (Stickgold & Walker, 2009). In short, sleep deprivation both harms the quality of sleep and negatively alters hormone secretions.

**The metabolic effects of the sleep cycle.** Metabolism depends on consolidated sleep for proper functioning (Stickgold & Walker, 2009). With sleep deprivation in
normal participants, glucose slows and pre-diabetic blood sugars are detected, implicating an increased risk for diabetes (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). Blood sugars tend to be lowest at night during slow wave sleep and peak during the morning in normal individuals. Over time in sleep deprived individuals, altering sleep means an altered fasting period, which causes a reduction in the insulin response to glucose, or a decreased glucose tolerance. As insulin and glucagon have an antagonistic relationship, both are heavily impacted by sleep deprivation (Cappuccio, Miller, & Lockley, 2010). As insulin levels rise in response to eating, then glucagon levels decrease. During fasting when blood glucose decreases, insulin diminishes and glucagon levels rise (Gropper, Smith, & Groff, 2009). Short sleepers have a reduced glucose tolerance in addition to higher evening cortisol levels as a consequence of their sleep deprivation (Cappuccio, Miller, & Lockley, 2010).

Leptin, the hormone responsible for fullness, reducing appetite, and adequate energy supply, is also tied to circadian rhythms and peaks at night during sleep (Lockley & Foster, 2012; Stickgold & Walker, 2009). With sleep deprivation, leptin levels are weaker with a smaller peak during the sleeping period; over time, this negative feedback increases (Stickgold & Walker, 2009). Ghrelin, the hormone that signals hunger to the brain, is elevated during sleep deprivation along with appetite (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). Disrupted sleep is associated with a negative energy balance, a tendency to favor more carbohydrates, an overall higher caloric intake, and an increased body mass index, or BMI (Chaput, Després, Bouchard, & Tremblay, 2008; Kathrotia, Rao, Paralikar, Shah, & Oommen,
The Thermoregulatory Effects of the Sleep Cycle

Sleep deprivation also alters the regulation of body temperature. In normal sleep, homeostatic temperature adjustments will continue into the later stages of sleep. With chronic sleep deprivation, body temperature is elevated, and then decreases as the deprivation goes on without regulation (Stickgold & Walker, 2009). With increases of body thermogenesis with sleep deprivation and these altered hormone levels, weight gain is to be expected in both short and long sleepers following a “u-shape” pattern, and obesity or other health effects are very likely (Cappuccio, Miller, & Lockley, 2010; Chaput, Després, Bouchard, & Tremblay, 2008; Hublin, Partinen, Koskenuvo, & Kaprio, 2007; Lockley & Foster, 2012).

The Immunity and Disease Effects of the Sleep Cycle

The HPA axis is also tied to immune function. Sleep is also often noted as the connection between stress and the immune system (Pandi-Perumal, Cardinali, & Chrousos, 2007). Studies have shown reduced antibodies as a result of the impact of stress on sleep disturbances and the immune system (Lockley & Foster, 2012; Pandi-Perumal, Cardinali, & Chrousos, 2007; Stickgold & Walker, 2009). In addition, C-reactive protein levels are often increased to abnormal levels (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). These proteins are also seen elevated in conditions of obesity, cardiovascular disease, and diabetes (Stickgold & Walker, 2009). The HPA axis is also elevated in the incidence of sleep disorders, such as insomnia and sleep apnea (Pandi-Perumal, Cardinali, & Chrousos,
Both sleep disorders and chronic inflammatory diseases are also related in their detrimental effects (Lockley & Foster, 2012; Pandi-Perumal, Cardani, & Chrousos, 2007). The symptoms of fatigue, muscle stiffness, and pain are a result of the non-restorative sleep found exhibited with these conditions (Pandi-Perumal, Cardani, & Chrousos, 2007). Due to these inflammatory increases, often those who are sleep deprived are at higher risk for cancer, stroke, and heart attack (Lockley & Foster, 2012).

Depression is also a key result of sleep deprivation (Hublin, Partinen, Koskenuvo, & Kaprio, 2007; Pandi-Perumal, Cardani, & Chrousos, 2007; Regestein, Natarajan, Pavlova, Kawasaki, Gleason, & Koff, 2010). In addition, sleep deprivation due to stress and depression has been studied by Pandi-Perumal et al. to hasten the onset of lupus; in these patients, hormone levels never returned to baseline (2007). In a different light, depression has also been studied with sleep-deprived women with “problematic sleepiness” being the highest depressive indicator and behavioral factors such as caffeine consumption and later bedtimes being the most to blame (Regestein, Natarajan, Pavlova, Kawasaki, Gleason, & Koff, 2010).

**The Behavioral Effects of the Sleep Cycle**

In terms of behavior, the risk of an automobile crash or other accident is 2.3 times more likely in someone who is sleep deprived versus an individual with adequate sleep (Stickgold & Walker, 2009). Aside from drowsiness, spending less time awake, an altered circadian rhythm, less sleep, and often the use of sleep drugs all factor into accident risk (Lockley & Foster, 2012; Stickgold & Walker, 2009; Sutton, 2005). College students have a similar pattern of using alcohol and other substances, as well as
higher rates of accidents due to sleepiness (Sutton, 2005; Taylor & Bramoweth, 2010).

The sleep-wake system begins to break down the longer one goes without sleep and microsleeps may occur (Lockley & Foster, 2012; Stickgold & Walker, 2009; Sutton, 2005). Microsleeps, or brief episodes of sleep that occur during time awake, often result in errors or lapses in judgment (Stickgold & Walker, 2009). In addition, the attentional neuronal networks in the brain are often disrupted by sleep deprivation (Stickgold & Walker, 2009; Sutton, 2005). Other cognitive functions like critical thinking merely slow during sleep deprivation; problem-solving skills are increasingly more difficult as a result, and working memory becomes increasingly impaired as deprivation continues. Mood can also be impacted, with a tendency to favor more negative states (Lockley & Foster, 2012; Stickgold & Walker, 2009). Increases in aggression and risk-taking may also be present, as well as the risk of committing suicide (Cappuccio, Miller, & Lockley, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). Overall, too much or too little sleep over time has an increased risk for mortality, and medication use exacerbates this risk (Cappuccio, Miller, & Lockley, 2010; Hublin, Partinen, Koskenuvo, & Kaprio, 2007).

**Tools to Determine Sleep Quality and Related Measures**

While many aspects of sleep are subjective, there are several assessments that practitioners use to best describe sleep quality in the medical setting. The most prominent tool is the Pittsburgh Sleep Quality Index (PSQI). This 19 question survey is self-rated by the subject, and if applicable, there are five questions for a spouse or housemate to also answer, but these questions are not tabulated in the overall PSQI score.
(Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989). It focuses on how long an individual sleeps, how many times they wake up, and on detailed questions probing about the overall restfulness of the slumber, all within the past month of time. The tool is used to determine “good” and “bad” sleepers, all while being simple for participants to take and practitioners to score. There are component scores on subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction; all of these scores sum to the global PSQI score (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989).

Looking at circadian rhythms, the Morningness-Eveningness Questionnaire (MEQ) is most often used to evaluate the tendencies of individuals to favor either the morning or evening or an intermediate of both (Chelminski, 2000; Horne, 1976). This questionnaire gives 19 questions with four “forced-choice” responses, indicating definite morning type, moderate morning type, moderate evening type, and definite evening type (Horne, 1976). The questions ask about bedtimes and wake times, as well as preferred times of mental or physical performance (Chelminski, 2000). The sums of all the numerical values per question are then totaled and then converted to the five-point Morningness-Eveningness Scale, where “neither type” is the fifth option (Horne, 1976). This tool has various applications, including the determination of a start time for light therapy in seasonal and non-seasonal depression patients (Terman, Rifkin, Jacobs, & White, 2008).

Several questionnaires measure disrupted sleep. The Basic Nordic Sleep Questionnaire (BNSQ) stresses how often a particular symptom occurs on a five point
scale, from 1, “never, or less than once per month,” to 5, “every night or almost every night” over the course of the past three months (Partinen & Gislason, 1995). This tests 27 different items in 21 questions, including questions on sleep duration and bed and wake times, yet is more focused on snoring. This tool is routinely used in Finland and Iceland for routine clinical patient questionnaires, but is also applicable to sleep apnea and insomnia (Partinen & Gislason, 1995; Veldi, Aluoja, & Vasar, 2005). In contrast, the Epworth Sleepiness Scale (ESS) measures the probability of falling asleep in a variety of situations (Johns, 1993). This test in particular is helpful for the diagnosis of obstructive sleep apnea syndrome (OSAS), as it measures the degrees of daytime sleepiness in a subject (Sutton, 2005). It has eight questions, each consisting of a scenario and the subject rates their reaction on a scale of 0-3, with 3 being ‘the almost always likely to doze’ score (Johns, 1993; Sutton, 2005). The scores for all of the questions are then totaled for an overall ESS score, but each question can be looked at alone to pinpoint the conditions that make the subject sleepy as well. It is a more objective form of assessment that focuses on anywhere from a month to a year depending on the subject and their needs, versus some of the questionnaires that concern the span of a month or several (Sutton, 2005).

Sleep Trends in College Students

Due to a wide variety of academic, social, and personal factors, sleep is often restricted and irregular in college students (Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997). As students do not often get sufficient sleep during the week, long sleep duration on weekends is common and delayed sleep syndrome
occurs (Brown, Buboltz, & Sopher, 2002; Eliasson, Lettieri, & Eliasson, 2010; Gaultney, 2010; Lund, Reider, Whiting, & Prichard, 2010; Vela-Bueno, Fernandez-Mendoza, Olavarrieta-Bernardino, Vgontzas, Bixler, de la Cruz-Troca, Rodriguez-Muñoz, & Oliván-Palacios, 2008). Even a shift of two hours in the normal sleep schedule is enough to cause the physical and psychological effects often seen in sleep deprivation. Students with a varied class schedule, for example, have shorter sleep durations and a harder time waking up during the week (Brown, Buboltz, & Sopher, 2002). A study from Liguori et al. found that sleep duration in college students (n=820) actually changes throughout the course of the semester in relation to workload by increasing slightly; this could be due to increased time management (2011). However, from 7.5 hours of sleep per night in 1969 to 6.5 hours in 1989, this population continues to lose sleep overall (Brown, Buboltz, & Sopher, 2002). A study from Sweileh et al. found students to have an even lower average of 6.4 hours of sleep per night (2011).

**Sleep Quality in College Students**

Sleep quality, or the number of awakenings at night, as well as sleep latency, depth, and duration, often suffer in the collegiate population; only 11% of students studied were considered to have “good” sleep quality (Brown, Buboltz, & Sopher, 2002; Pilcher, Ginter, & Sadowsky, 1997). College students tend to have poor satisfaction with the quality of their sleep, with only 42% being satisfied in a study by Eliasson et al. (2010). Class year in school can impact total sleep time and quality, with freshmen sleeping 20 minutes longer than upperclassmen, on average (Liguori, Schuna, & Mozumdar, 2011). Sleep quality can also be associated with academic progress, illness,
social activities, stress and living conditions (Lund, Reider, Whiting, & Prichard, 2010; Veldi, Aluoja, & Vasar, 2005). Stress is one of the top factors in predicting sleep quality, impacting sleep quality scores by up to 13.5% on the PSQI (Lund, Reider, Whiting, & Prichard, 2010). Sleep quality is better related to measures of health and well-being versus sleep quantity, in students averaging seven to eight hours of sleep a night (Pilcher, Ginter, & Sadowsky, 1997). Poor sleep quality has been associated with increased physical complaints as well as anger, depression, confusion, and fatigue (Brown, Buboltz, & Sopher, 2002; Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997). Poor problem solving, increased alcohol use, and sleeping pill use also diminish sleep quality (Brown, Buboltz, & Sopher, 2002; Veldi, Aluoja, & Vasar, 2005).

Additionally, sleep management courses have been proven to increase sleep quality, yet they do not change the overall sleep patterns (Gaultney, 2010).

**Sleep hygiene in college students.** Proper sleep hygiene is crucial to improving sleep quality. Often, waking up at the same time every day is the first step in improvement (Brown, Buboltz, & Sopher, 2002). Reducing caffeine intake, alcohol consumption, and long afternoon naps as well as regular exercise also assist with changing hygiene habits (Brown, Buboltz, & Sopher, 2002; Lund, Reider, Whiting, & Prichard, 2010; Vela-Bueno, Fernandez-Mendoza, Olavarrieta-Bernardo, Vgontzas, Bixler, de la Cruz-Troca, Rodriguez-Muñoz, & Oliván-Palacios, 2008). Alcohol and naps are used to combat sleepiness but actually make it more difficult to fall asleep and maintain sleep; poor sleepers drink more alcohol and twice as often (Brown, Buboltz, & Sopher, 2002; Lund, Reider, Whiting, & Prichard, 2010). Additionally, drinking coffee
in the late afternoon and evening also delays sleep (Sweileh, Ali, Sawalha, Abu-Taha, Zyoud, & Al-Jabi, 2011). Changes in environment to make it more conducive to sleep also improve sleep quality, but depending on where a student resides, certain factors may be difficult to change, especially in a college dormitory (Brown, Buboltz, & Sopher, 2002; Gaultney, 2010). Schedules for work and school are also not complementary to good sleep hygiene practices (Liguori, Schuna, & Mozumdar, 2011).

**Sleep Disturbances and Disorders in College Students**

Sleep disturbances are common in this population; two thirds of college students report occasional difficulties, and a third suffers from regular disturbances (Brown, Buboltz, & Sopher, 2002). In one study by Gaultney, 27% of students were at risk for at least one sleep disorder (2010). Restless leg syndrome affected 22% of students, whereas 9% of students suffered from sleep bruxism or snoring (Sweileh, Ali, Sawalha, Abu-Taha, Zyoud, & Al-Jabi, 2011; Veldi, Aluoja, & Vasar, 2005). Additionally, over 40% of college students have difficulties in falling asleep. Waking up at night is also common; almost two thirds of students woke up more than once a night (Sweileh, Ali, Sawalha, Abu-Taha, Zyoud, & Al-Jabi, 2011). Nightmares and insomnia related to daytime sleepiness and maintaining sleep also tie in to sleep quality in students; this daytime sleepiness can be attributed to an increased BMI, snoring, diminished sleep quality, and sleep deprivation (Gaultney, 2010; Kathrotia, Rao, Paralikar, Shah, & Oommen, 2010; Pilcher, Ginter, & Sadowsky, 1997; Veldi, Aluoja, & Vasar, 2005).

**Academic Performance in College Students**

Insufficient sleep time and the sleepiness and inattentiveness that follow are the
major factors in poor academic performance in college students (Eliasson, Lettieri, & Eliasson, 2010; Gaultney, 2010). In a study by Eliasson et al., students had an average of 7 hours and 23 minutes of sleep on weeknights and 8 hours and 43 minutes of sleep on weekend nights, but it is the bed time and wake times that have the greatest effect on academic performance (2010). Students with a higher grade point average (GPA) have earlier bedtimes and earlier wake times, by 30-45 minutes (Eliasson, Lettieri, & Eliasson, 2010). The consistency of the overall sleep schedule also impacts academic performance (Gaultney, 2010). In addition, these high performers were more likely to take naps, although naps are taken by students regardless of academic performance to get sleep in during the day (Eliasson, Lettieri, & Eliasson, 2010; Vela-Bueno, Fernandez-Mendoza, Olavarrieta-Bernardino, Vgontzas, Bixler, de la Cruz-Troca, Rodriguez-Muñoz, & Oliván-Palacios, 2008). Risk for sleep disorders predicts GPA and student persistence in college; proper sleep hygiene is crucial to avoid this detrimental risk (Gaultney, 2010). These findings support the current trends of schools to delay start times and offer variability in course offerings to allow for a better nights’ sleep and to increase productivity in college students (Eliasson, Lettieri, & Eliasson, 2010).

**What is Caffeine?**

Caffeine is the world’s most popular drug, with over 85% of Americans using it on a daily basis (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). It has the chemical formula C₈H₁₀N₄O₂ and can be chemically named 1,3,7-trimethylxanthine, 1H-Purine-2,6-dione, 3,7-di hydro-1,3,7-trimethyl,
methyltheobromine, 1,3,7-Trimethyl-2,6-dioxopurine, and 7-Methyltheophylline (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Weinberg & Bealer, 2001). Caffeine is part of the pure alkaloid group, which are sometimes called methylated xanthines; its isomers are theophylline, theobromine, and paraxanthine (Spiller, 1998; Weinberg & Bealer, 2001). Pure caffeine can be isolated from waste tea leaves and coffee undergoing the decaffeination process, and it is also the product of dimethylurea and malonic acid or methylated theophylline or theobromine (Weinberg & Bealer, 2001). It cannot melt and is moderately soluble in water similar to the average human body temperature, but is fully soluble in hot water (Weinberg & Bealer, 2001).

**The Absorption and Metabolism of Caffeine**

Caffeine is metabolized quickly because of its water solubility, and is absorbed in the stomach and intestines (Weinberg & Bealer, 2001). Alterations in pH or food present in the gastrointestinal tract affect the rate of absorption (James, 1997; Spiller, 1998). Once in the liver, 98% of the ingested amount is then metabolized by cytochrome p450 monooxygenase into many metabolites through several steps; less than two percent of the end product trimethyl uric acids, like 1-methyluric acid, are then excreted in the urine. The untouched remaining 2% is then distributed via the blood as a demethylated compound, like paraxanthine, theophylline, or theobromine (Chambers, 2009; James, 1997; Weinberg & Bealer, 2001). These compounds continue to break down further into one of 25 different metabolites for hepatobiliary elimination by enzymes CYP1A2, CYPE1, xanthine oxidase, and N-acetyltransferase (Chambers, 2009).

Caffeine, mostly as paraxanthine, is transported amongst all body tissues and
secretions equally, from breastmilk to saliva and semen (Chambers, 2009; James, 1997; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). Caffeine also passes through the blood-brain barrier in the central nervous system via simple diffusion and carrier-mediated transport (Chambers, 2009; Weinberg & Bealer, 2001). It is then that the metabolic rate, serotonin secretion, heart rate, norepinephrine/epinephrine secretion, gastric secretion, smooth muscle relaxation, glomerular filtration, skin temperature, muscle contractility, and urinary output all increase (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998). Peak caffeine concentrations occur from 15-120 minutes after ingestion (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001). The concentrations of caffeine in the body rely on a multitude of factors. Metabolism is slowed, meaning that it stays in the body longer, by alcohol, Asian ethnicity, oral contraceptives, liver damage, the luteal phase of the menstrual cycle, high altitudes, pregnancy, and by being male or a newborn. Cigarettes, Caucasian ethnicity, and female or child status speed metabolism of the drug (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Weinberg & Bealer, 2001).

Additionally, theobromine is an inhibitor of itself and caffeine, so habitual caffeine consumers may find an extended effect (Chambers, 2009; Weinberg & Bealer, 2001). Since caffeine metabolizes quickly, it does not accumulate within the body. As the theobromine and caffeine forms do not bind to plasma albumin, they do not additionally break down; this extended period gives caffeine its half-life of 2-4 hours and up to 9.5 hours, with variable times between age, gender, and substance use (Chambers, 2009;
The Function of Caffeine

Caffeine functions in the brain as nonselective A1 antagonist, blocking the receptors responsible for injury reaction and collagen production (James, 1997; Stickgold & Walker, 2009). It can also block the A2 receptor with the addition of an alkyl group. It has a large effect on phosphodiesterase; this increases cyclic adenosine monophosphate (cAMP), the activation of protein kinase A, and also blocks inflammatory responses. The A1 and A2 receptors work together to help regulate wakefulness and sleep; A2 receptors are abundant in striatal neurons and help to balance out the majority effect of A1 receptors (Stickgold & Walker, 2009).

The Lasting Effects of Caffeine

As it is a drug, caffeine can have both dependence and withdrawal. Chronic use of caffeine even at 100 mg per day can produce tolerance and withdrawal symptoms over time (Huntley & Juliano, 2011). The time it takes to reach tolerance and dependence vary from individual to individual due to the wide array of factors that can influence caffeine metabolism as well as daily intakes. Sleepiness, impaired concentration, irritability, decreased sociability, and even muscle aches can happen as early as 12 hours after the last caffeine intake; this peaks within one to two days, and can last as up to one week if no caffeine is consumed (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Weinberg & Bealer, 2001). Often, a caffeine headache is the most noted withdrawal symptom
(James, 1997; Spiller, 1998; Weinberg & Bealer, 2001). As with metabolism, a multitude of factors can determine the length and severity of withdrawal. Caffeine withdrawal is attributed to the cessation of adenosine antagonism, and the large number of empty adenosine binding sites (Chambers, 2009; Weinberg & Bealer, 2001). In extreme cases, this dependence and withdrawal can evolve into caffeine intoxication or “caffeinism”; there are entries in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR)* that refer to this regular excessive consumption of caffeine and the related disorders (Chambers, 2009; Weinberg & Bealer, 2001).

**Sources of Caffeine**

Found naturally in over 60 species, caffeine has evolved as a protective mechanism to kill bacteria, fungi, weeds, and insects in plants (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Spiller, 1998; Weinberg & Bealer, 2001). Humans have continued to discover these different caffeinated plants across different continents and time periods, as early as 700,000 B.C. (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Weinberg & Bealer, 2001). Today, more than 80% of American adults consume caffeine on a daily basis with an average of 200 mg consumed per day (Norton, Lazev, & Sullivan, 2011; Shohet & Landrum, 2001; Weinberg & Bealer, 2001). At room temperature, the compound caffeine is odorless, white, bitter, and in a powder or crystal structure. However, it is not available on the market in this form (Alpert, 2012; James, 1997; Weinberg & Bealer, 2001). As a drug, caffeine is present in a wide variety of substances, from coffee, tea, and sodas to weight loss drugs and medications. It can also be taken as
a pill to vanquish sleep (Wilson & Temple, 2004).

**Caffeine in Cocoa**

Chocolate is the single most craved food (Spiller, 1998). Cocoa, used to make chocolate products, is obtained from the cacao tree *Theobromine cacao* (James, 1997). The pods from these trees contain beans which are then fermented to attain the characteristic “chocolate” color and flavor (Weinberg & Bealer, 2001). Chocolate liquor is a semisolid food prepared by grinding the nib of the cacao bean. It is sometimes known as baking chocolate, cocoa paste, or chocolate mass. Any chocolate product begins with chocolate liquor (Spiller, 1998). Cocoa butter, or the fat portion of chocolate liquor, only has a trace amount of caffeine (Spiller, 1998). Cocoa powder is a preparation of the remaining material once cocoa butter is taken out of the cocoa, and is used for baking and flavoring. As caffeine is present in lipid only in trace amounts, cocoa powder has a higher concentration of caffeine than the chocolate liquor. The powder can also be prepared from cocoa liquor (Spiller, 1998).

Cacao products have more ten times more theobromine in them versus other products, in addition to caffeine; as theobromine is not as potent, the caffeine dominates (Weinberg & Bealer, 2001). Major sources include chocolate bars, hot cocoa mix, and chocolate milk, but these caffeine contents are quite low compared to the other beverage formulations that include caffeine (Weinberg & Bealer, 2001). Chocolate bars and other chocolate confections vary in caffeine content, but all are made from chocolate liquor. Dark “sweet” chocolate has 15-50% chocolate liquor, semisweet chocolate has at least 35% chocolate liquor, and milk chocolate has 10-12% chocolate liquor. The more
chocolate liquor present, the more caffeine that product has (Spiller, 1998). Using unsweetened cocoa to make hot chocolate yields 6-42 mg of caffeine, depending on the source (Spiller, 1998). Instant hot cocoa mixes provide 10-17 mg of caffeine per cup, and chocolate milks provide 5-10 mg of caffeine per serving. Caffeine content in these products varies on if a consumer is making something at home versus using something pre-made and store-bought (Spiller, 1998).

**Caffeine in Other Foods**

In West Africa, *Cola acuminata* and *Cola nitida* trees produce the cola nut. These can be chewed for energy or used as an ingredient in medicines and soft drinks (Weinberg & Bealer, 2001). Cola nuts have 2% caffeine by weight (Spiller, 1998). The nuts themselves contain kolanin, a fruit sugar that amplifies the large caffeine boost these nuts provide (Weinberg & Bealer, 2001).

**Caffeine in Tea**

Fourteen percent of American caffeine is found in tea (Weinberg & Bealer, 2001). Tea, or *Camellia sinesis*, is the second highest consumed beverage in the world, second to water (James, 1997; Spiller, 1998). The four major types of tea are black tea, green tea, oolong tea, and white tea (James, 1997). Black tea has the highest concentration of caffeine and is made by withering, rolling, and then fermentation, or the oxidation of green leaf polyphenols (James, 1997; Spiller, 1998). The leaves are then fired and graded. Black tea grades include orange pekoe, broken orange pekoe, broken orange pekoe fannings, and dust (Spiller, 1998). This type of tea accounts for nearly 80% of worldwide tea production, whereas green tea makes up 18% of tea production (James,
In the United States, black tea is commonly prepared as iced tea and there is also a common powder instant tea preparation. Once prepared, this can offer 5% caffeine by weight, or about 30 mg brewed (Spiller, 1998).

Green tea is a dry product without oxidation (James, 1997). Green tea caffeine content can vary by the consistency of the tea. Sen-cha, or regular green tea has 2.8 percent caffeine by weight; mac-cha, or the powdered green tea made from the smallest and most caffeinated young tea leaves, has 4.6 percent caffeine by weight; and ban-cha, or coarse tea has 2 percent caffeine by weight (Weinberg & Bealer, 2001). During the cultivation process, the addition of nitrogen from fertilizers can increase caffeine as much as 40% (Spiller, 1998).

Oolong tea is partially oxidized and is an intermediate between black and green tea in color, flavor, and caffeine content (James, 1997; Spiller, 1998). White tea is the newest form of tea, with the most antioxidants and is made from immature tea leaves. There are no tannins in this type of tea and white tea tends to have the lowest caffeine content at 15 mg per cup (Pacific College of Oriental Medicine, 2006).

**Caffeine in Coffee**

Coffee is the top source of caffeine in adults, with 70% of caffeine in the United States found in coffee beans (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Weinberg & Bealer, 2001). Globally, it is the most popular beverage, consumed by 90% of adults (Alpert, 2012). Coffee is produced by taking green coffee beans and processing through the wet or dry method (Spiller, 1998). The wet method uses fermentation to eat away at the layers of the coffee bean, getting it
down to the parchment layer of the bean. Beans are then hulled to get the endosperm layer off to be ready for processing (Spiller, 1998). The dry method involves taking the ripe coffee berries out to dry in the sun. Internal microorganisms cause the outer layers to dry out; this thick skin is hulled off to reveal the silverskin or spermoderm layer. The beans are then soaked and re-hulled to remove this skin and the beans are ready for processing (Spiller, 1998). Processing after either the wet or dry method can include decaffeination or roasting, grinding, and storage (Spiller, 1998).

The two major classes of coffee beans, *Coffea Arabica* and *Coffea canephora*, or Arabica and Robusta, respectively, come from the *Rubiaceae* family in the *Coffea* genus (James, 1997; Spiller, 1998). Arabica is the most widely grown species, is used for brewed coffee, and has 0.58-1.7% caffeine by weight in its dry green bean form and 1% caffeine by volume, brewed (James, 1997; Spiller, 1998; Wilson & Temple, 2004). Robusta is mainly used for instant coffee mixes and has 1.16-3.27% caffeine by weight in its bean form and 2% caffeine by volume, brewed; instant coffee is often a mixture of both Arabica and Robusta (James, 1997; Spiller, 1998; Wilson & Temple, 2004). Arabica has half of the caffeine content as well, due to the bean’s high lipid content (James, 1997; Stickgold & Walker, 2009; Weinberg & Bealer, 2001).

Roasting coffee can alter its caffeine content, as it burns away caffeine and water. A dark roast will have more caffeine by bean weight, but a light roast will have more caffeine by coffee volume (Stickgold & Walker, 2009). Espresso is not a coffee bean but simply a fine grind of a coffee, usually of the Arabica variety (Stickgold & Walker, 2009). As it is typically a darker roast, it tends to have less caffeine than coffee. But like
with coffee, the amount of water and the length of brewing are the best determinants for caffeine strength; 90% of caffeine is extracted during the first minute of brewing (Spiller, 1998; Stickgold & Walker, 2009). Depending on the quantity of coffee, the bean type, and the strength, a cup of coffee can contain 40-400 mg caffeine, with the average six ounce cup having 60-180 mg (Weinberg & Bealer, 2001). It should be noted that decaffeinated coffee also has a caffeine content of 5-25 mg per serving, depending on preparation (Alpert, 2012; Wilson & Temple, 2004).

**Caffeine in Soft Drinks**

Soft drinks are a major source of dietary caffeine and account for one out of four beverages consumed in the United States (Wilson & Temple, 2004). Every six out of seven soft drinks contain caffeine as well (Wilson & Temple, 2004). They either utilize the cola nut, *Cola acuminata*, or add caffeine in during the production process (James, 1997; Weinberg & Bealer, 2001). If the cola nut is used, it only accounts for five percent of the total caffeine content (Weinberg & Bealer, 2001). The caffeine added in is the product of coffee and tea decaffeination that is added in to the cola or soda flavorings, such as vanilla or citrus (Weinberg & Bealer, 2001). Sometimes it can both flavor the beverage and provide the caffeine boost in a product (Weinberg & Bealer, 2001). Not all soft drinks contain caffeine, such as 7-UP (Weinberg & Bealer, 2001). The soft drinks that do contain caffeine range widely in content, like Coca-Cola at 46 mg caffeine per 12-ounce can to Mountain Dew, with 55 mg caffeine per 12-ounce can (Wilson & Temple, 2004). Flavored soft drinks like Minute Maid orange soda have 0 mg of caffeine, while Sunkist orange soda has 42 mg; even similar soft drinks may vary widely in their caffeine
content due to their ingredients (Wilson & Temple, 2004).

**Caffeine in Other Beverages**

In South American countries, yerba maté is the primary source of caffeine (James, 1997). The leaves from the *Ilex paraguariensis* plant can be steeped to create a beverage, maté, with a caffeine level lower than tea (James, 1997; Weinberg & Bealer, 2001). Caffeine content in these tea-like beverages is widely variable due to the 60 plant species that are used to make it in addition to *Ilex paraguariensis* (Weinberg & Bealer, 2001). The age of the leaves also impacts its caffeine content; young maté leaves are two percent caffeine by weight, while old leaves greater than two years old only have 0.7% caffeine. Per six ounce serving, a cup of maté can contain 25-100 mg of caffeine (Weinberg & Bealer, 2001).

Guarana, or *Paullinia cupana* is also highly popular in South America and increasingly becoming present in Europe and the United States (Weinberg & Bealer, 2001). The seeds of this plant can be ground into a powder, but most often they are roasted and brewed to make a tea-like beverage. Guarana seeds offer five percent caffeine by weight and are perceived to be stronger and less jittery than coffee when consumed (Weinberg & Bealer, 2001). Guarana can also be sweetened to make its own soft drink, added to herbal teas, or consumed as a capsule. Yoco bark, from the *Paullinia yoco* tree, is used to prepare a similar caffeinated beverage (Weinberg & Bealer, 2001).

**Caffeine in Energy Drink Supplements**

Energy drinks are the newest source of caffeine on the market, debuting with Red Bull in 1997 (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007;
Wolk, Ganetsky, & Babu, 2012). About 31% of all young adults consume these beverages (Alpert, 2012). There were over 500 different drinks on the market in 2006; these drinks employ caffeine, guarana, B vitamins, herbal extracts, ribose, amino acids, and other additives to give users a “jolt” of energy (Attila & Cakir, 2011; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007; Pettit & DeBarr, 2011; Wolk, Ganetsky, & Babu, 2012). Popular brands on the market include and are not limited to: Full Throttle, Rockstar, Cocaine, Red Bull, Monster, NOS, and AMP (Attila & Cakir, 2011; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007; Pettit & DeBarr, 2011; Wolk, Ganetsky, & Babu, 2012). Caffeine contents vary widely, as do the portions offered - there can be 50-500 mg of caffeine in one can or bottle (Arria, Caldeira, Kaperski, Vincent, Griffiths, & O’Grady, 2010; Attila & Cakir, 2011).

Energy shots, a spin-off of these beverages, contain as much caffeine as a cup of coffee in a two ounce portion (Wolk, Ganetsky, & Babu, 2012). Due to the concentrated nature of these beverages and the fact that they are unregulated supplements, energy drinks are a major health concern, especially in the adolescent and young adult populations (Wolk, Ganetsky, & Babu, 2012).

Caffeine Pills

Caffeine is the only alertness aid for sale by the Food and Drug Administration (FDA) (Weinberg & Bealer, 2001). The top selling caffeine pills on the market today are Vivarin and No-Doz (Weinberg & Bealer, 2001). Vivarin is specifically marketed towards college students, as well as truck drivers and bodybuilders (Weinberg & Bealer, 2001; Wilson & Temple, 2004). Vivarin in particular claims that “caffeine improves
confidence, increases alertness, and improves performance during all-nighters” and that “caffeine produces greater alertness, heightened concentration, and reduces mental fatigue.” One Vivarin pill has 200 mg caffeine per pill, and No-Doz has 100 mg (Weinberg & Bealer, 2001).

Caffeine in Other Supplements

There are over one thousand different products that include caffeine as an ingredient to speed up some aspect of metabolism or drug delivery (Weinberg & Bealer, 2001). These include stimulants, pain relievers, diuretics, cold remedies, and weight-loss medications. It often is used in pharmaceutical preparations to speed up various bodily processes (James, 1997; Weinberg & Bealer, 2001). Migraine drugs like Excedrin contain 65 mg of caffeine, whereas menstrual relief drugs like Midol contain 35 mg (Shohet & Landrum, 2001; Weinberg & Bealer, 2001). Weight loss drugs like Dexatrim have 200 mg of caffeine, while cold remedy Triaminicin has 30 mg (Johnson-Greene, Fatis, & Shawchuck, 1988; Weinberg & Bealer, 2001). The average caffeine amount in herbal supplements is 359 mg per serving, on average (Andrews, Schweitzer, Zhao, Holden, Roseland, Brandt, Dwyer, Picciano, Saldanha, Fisher, Yetley, Betz, & Douglass, 2007). Additionally, caffeine is often present in street drugs (James, 1997).

Uses and Reasons for Caffeine Consumption

People consume caffeine for a wide variety of reasons. Habitual consumers eat and drink caffeine because it makes them feel better, gives them more energy, helps them relax, and is refreshing (James, 1997). Others consume caffeine to stay awake, increase athletic performance, or to lose weight (Institute of Medicine (U.S.) Committee on
Military Nutrition Research, 2001). There are a wide variety of pros and cons to caffeine consumption; like any other food or beverage, moderation is key.

**Benefits of Caffeine Usage**

The consumption of caffeine to reap its benefits is highly dose-dependent and task-dependent. There is a lack of consistency on what defines an optimal dose, but anything above 500-600 mg is unlikely to be beneficial (James, 1997; Schellack, 2012). For tasks that may extend longer periods, 200-400 mg caffeine has been successful in sustaining an improvement (Stickgold & Walker, 2009; Weinberg & Bealer, 2001).

**Caffeine as an ergogenic aid.** Caffeine is well known for its ergogenic properties. Under current rulings, the International Olympic Commission (IOC) has ruled that athletes may not exceed a urinary concentration reflective of 500-600 mg of caffeine (12 μg/mL) within one to two hours pre-competition. As individual metabolisms vary, a few cups of coffee could make an athlete ineligible (James, 1997).

For endurance exercises like cycling and running, caffeine offers great enhancement (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). An individual would take the drug one hour before the exercise maintaining 75-80% maximal oxygen uptake (VO₂ max) (James, 1997; Spiller, 1998). Higher caffeine doses are better, at approximately six to eight cups of coffee worth of caffeine (James, 1997). These ergogenic effects are due to caffeine’s stimulation of lipolysis and the sparing of the athlete’s glycogen stores (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997).
Aside from caffeine’s beneficial effects with endurance, strength or short-term endurance exercises do not benefit from the drug (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998). In these cases, caffeine may actually diminish muscle tone (Spiller, 1998). Caffeine also helps to lower the rate of perceived exertion (RPE), or a person’s sense of fatigue (Weinberg & Bealer, 2001).

**Caffeine and work.** Aside from behavioral treatments, caffeine has been shown to improve work, especially in shift workers (James, 1997). Caffeine has also been used with truck drivers to increase alertness; the drug improves driver safety and reduces the risk for automobile accidents (Weinberg & Bealer, 2001). Additionally, a study by De Valck and Cluydts found that 300 mg of slow-release caffeine counteracted some of the driving effects of sleep deprivation in truck drivers (2001). In a different study with the United States Air Force, caffeinated tube foods kept pilots at or above baseline cognitive functioning levels for a nine hour overnight period (Doan, 2006).

**Caffeine and mental health.** There have been a lot of inconsistencies with studies on caffeine, vigilance, and memory (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997). An overall relationship between caffeine, arousal, and performance is thought to be U-shaped (James, 1997; Spiller, 1998). Caffeine has been shown to improve cognitive functioning like reaction time, attention, and memory, as well as wakefulness at different caffeine doses (Heckman, Weil, & Gonzalez de Mejia, 2010; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). Caffeine works
best with long term memory, “rewiring” the brain’s dendritic spines to grow, connect, and form new dendrites, augmenting brain function (Weinberg & Bealer, 2001). Caffeine can reverse declines in performance on tasks that are boring or that induce fatigue (James, 1997). With sleep deprivation, more caffeine is required for the same effect (Stickgold & Walker, 2009).

Caffeine can promote some positive mood effects, including being more at ease, more physically active, and less irritable, especially in habitual consumers (James, 1997). A dosage of 250 mg is appropriate to achieve this affect (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001). Higher intakes of caffeine have also been associated with lower risks of suicide (Weinberg & Bealer, 2001).

**Caffeine and weight loss.** Caffeine has also been a treatment for obesity, since it increases lipolysis and metabolic rate. From the caffeine consumption of 300 mg per day, an individual could see an increase in energy expenditure of 79 kcal per day; this aids in weight maintenance and some weight loss (Heckman, Weil, & Gonzalez de Mejia, 2010; James, 1997; Weinberg & Bealer, 2001). This effect has been studied in conjunction with ephedrine and weight loss is modest; due to ephedrine being illegal as a dietary supplement, this treatment is no longer a viable option (James, 1997). As obesity is related to a decreased sympathetic nervous system, agents like caffeine and the green tea extract EGCG help to correct this (Wilson & Temple, 2004). A study by Di Pierro et al. found that adding the EGCG extract to a low calorie diet brought losses of 14 kg versus 5 kg over a three month period (2009). With caffeine, energy expenditure is then increased and can lead to weight loss when consumed habitually (Wilson & Temple,
Caffeine’s other clinical applications. Caffeine’s most successful clinical application has been with treating neonatal apnea, or the cessation of spontaneous breathing, in premature babies. Caffeine stimulates respiration and reverses this condition (James, 1997; Weinberg & Bealer, 2001). Caffeine has also been included in analgesic drugs for headaches and other pain, as it is a vasoconstrictor on cerebral blood vessels. Withdrawal headache is a risk with this treatment, depending on the dosage and time frame of treatment (James, 1997). Caffeine is proven to have a protective effect against Parkinson’s disease. The drug protects dopamine levels, aids in walking, treats excessive daytime somnolence (EDS), and speeds the metabolism of Parkinson’s disease medications (Alpert, 2012; Chambers, 2009; Heckman, Weil, & Gonzalez de Mejia, 2010; Stickgold & Walker, 2009; Wilson & Temple, 2004). Caffeine is suitable for quantifying liver function due to its rapid absorption, total body distribution, and minimal renal retention. It serves as a probe in patients with alcoholic liver disease, as the rate of caffeine elimination is very low in this population. It is also used to test children for cystic fibrosis, since liver enzyme activity is so altered (James, 1997). Caffeine is additionally used to lower the seizure threshold during electroconvulsive therapy (James, 1997; Stickgold & Walker, 2009). Chronic use for two weeks reduces seizure severity due to caffeine blocking adenosine receptors (Stickgold & Walker, 2009). Caffeine also impacts fibrinolysis in regular coffee consumers by breaking down dangerous blood clots quickly (Weinberg & Bealer, 2001). Caffeine can help treat the human immunodeficiency virus type 1 (HIV-1) by inhibiting its replication via DNA repair
proteins and vector transduction. Caffeine compounds inhibit the Vpr-mediated growth arrest, and have a promising chance at being developed into an antiviral drug to treat HIV-1 infections (Chambers, 2009). Recently, caffeine was studied to decrease the risk of developing type II diabetes mellitus due to the lipid mobilization, increased glucose tolerance, and decreased glucose storage that it causes (Alpert, 2012; Heckman, Weil, & Gonzalez de Mejia, 2010). On a similar note, caffeine may be able to decrease some of the symptoms of metabolic syndrome based on some of the antioxidants and polyphenols it is often bound with, but this area needs more study (Heckman, Weil, & Gonzalez de Mejia, 2010).

**Caffeine’s benefits with tea.** Caffeine has specific benefits in relation to green tea. The catechin in the tea, epigallocatechin-3-gallate (EGCG), has been used as a form of chemotherapy for cancer as it causes apoptosis in cancer cells, inhibiting cell growth and stopping the cancer cycle (Wilson & Temple, 2004). Green tea has been suggested as a preventative for cancer as well (Spiller, 1998; Wilson & Temple, 2004). In China, green tea users saw a 30% reduction in stomach and esophageal cancer risk. Other studies with green tea have seen a reduction in oral, esophageal, gastric, pancreatic, and colon cancers, globally. Green tea is thought to have protective effect with bladder, colon, stomach, pancreatic, and esophageal cancers (Spiller, 1998; Wilson & Temple, 2004).

Tea extracts may have potential as functional foods for diabetics, as EGCG suppresses glucose production (Wilson & Temple, 2004). Coupled with the powerful antioxidants in it, tea has also been reported to increase longevity, decrease the
inflammation of arthritis, prevent tooth decay, increase healthy gut bacteria, and aid in hydration (Wilson & Temple, 2004). Green tea can also prevent the carcinogenicity of cigarette smoke and UV-light tumors; this supports another study that states caffeine has a protective role towards the DNA damage that causes UV radiation (Heckman, Weil, & Gonzalez de Mejia, 2010; Spiller, 1998).

**Caffeine’s benefits with cocoa.** Flavonols and procyanidin in cocoa protect red blood cell membranes after exposure to oxidative stress, and modulate nitric oxide synthesis, eicosanoid synthesis, and platelet function. Chocolate in both a bar and beverage form can inhibit hemostasis. Additionally, the cocoa butter from chocolate has no effects on blood lipid concentrations (Wilson & Temple, 2004).

**Dangers of Caffeine Usage**

Caffeine is a diuretic, and can increase urinary output for up to 24 hours following consumption (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Stickgold & Walker, 2009). For healthy individuals, this dehydration is not as life-threatening, but for others on prescribed diuretics or other conflicting drugs, this presents an unsafe situation. Aside from this unpleasant side effect, caffeine negatively impacts many facets of human health. It is still debatable if caffeine can be considered safe long-term (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001).

**Caffeine and the sleep-wake cycle.** Caffeine alters the natural circadian rhythms that determine hormone peaks and valleys in addition to wake and bed times. This impacts cognitive performance, motivation, and work; daytime sleepiness and never adjusting to the new sleep-wake cycle wears on the body over time (Verster, Pandi-
Perumal, & Streiner, 2008). Shift workers use caffeine to prevent fatigue, yet consumption in the hours before bed can bar sleep for the rest of the night and impact the next day. In combination with a nap, performance and wakefulness are maintained (Smith, 2002; Snel & Lorist, 2011; Verster, Pandi-Perumal, & Streiner, 2008). The desire to increase arousal exists based on the circadian rhythms, hence why most individuals have coffee in the morning and ease off of caffeine by the end of the day (Verster, Pandi-Perumal, & Streiner, 2008). Another time of important note is post-lunch, from two to three in the afternoon; this time period is at risk for more car accidents due to the increase in sleepiness. Napping and face washing have been proven to reverse this sleepiness (Verster, Pandi-Perumal, & Streiner, 2008). Stress can impact the sleep-wake cycle as well, causing insomnia. If sleep deprivation continues, illness and work absenteeism result (Snel & Lorist, 2011).

**Caffeine and heart health.** Caffeine has been studied in three main ways in relation to the heart: by looking at cholesterol, blood pressure, and the risk for cardiovascular disease (James, 1997). Cholesterol and coffee are statistically correlated, with boiled coffee increasing blood lipid concentration (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998). Filtered coffee does not have this effect, as this relationship is due to the small lipid content in coffee beans. Other methods of preparation impacted by this finding include Turkish, French-press, and espresso style coffee (Alpert, 2012; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998).

Looking at blood pressure, habitual consumers do not adapt to the blood pressure
raising effects of the drug (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997). These increases are modest, but important for individuals with cardiac conditions (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Stickgold & Walker, 2009). In a study by Charalambos et al., a dose of 250 mg caffeine raised systolic blood pressure 12.3 mm Hg and raised pulse pressure 7.4 mm Hg over three hours (2003). The blood pressure-raising effects as well as the resulting changes in cholesterol due to caffeine increase the risk for cardiovascular disease (James, 1997).

**Caffeine and bone health.** Bones are integral to a healthy body in old age. There is an increased risk of calcium being leached from the bones with caffeine intake (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997). Increased calcium excretion and decreased female bone mass support this (James, 1997). An increased risk of fractures has also been associated with carbonated beverages in general, including those with caffeine (James, 1997; Spiller, 1998).

**Caffeine at high intakes.** People that consume caffeine habitually build a tolerance, meaning that they will require more and more of the drug to achieve the same effects (James, 1997). With caffeine, this creates more adenosine receptors in the brain (James, 1997; Snel & Lorist, 2011). Effects of tolerance include disrupted sleep and increased cardiovascular function (James, 1997).

Physical dependence occurs after tolerance. Withdrawal, or a period without caffeine after habitual consumption, is harsh and can induce sleepiness, headaches, and decreased functioning; caffeine is usually the best treatment (James, 1997). In extreme
cases, caffeine causes chronic psychological issues. These caffeine-induced mental disorders (Table 2) are outlined in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR)* and include caffeine intoxication, caffeine-induced anxiety disorder, caffeine-induced sleep disorder, and caffeine-related disorder not otherwise specified (American Psychiatric Association, 2000; James, 1997). The symptoms of intoxication can progress further at one gram of caffeine, depending on tolerance; a lethal dose of caffeine may range from 5-10 g for an adult male and involve convulsions, aspiration, or dysrhythmias (Alpert, 2012; American Psychiatric Association, 2000; Schellack, 2012).

Table 2. Caffeine Disorder Criteria

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<th>Disorder</th>
<th>Criteria A.</th>
<th>B.</th>
<th>C.</th>
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<tr>
<td>305.90  Caffeine intoxication</td>
<td>Recent consumption of caffeine in excess of 250 mg</td>
<td>Five or more of the following during or after caffeine use: restless, nervousness, excitement, insomnia, flushed face, diuresis, gastrointestinal disturbance, muscle twitching, rambling thought or speech, cardiac arrhythmia/tachycardia, periods of inexhaustibility, psychomotor agitation</td>
<td>Symptoms in criterion B cause clinically significant distress or impairment in functioning</td>
<td>Symptoms are not due to a general medical condition and are not better accounted for by another mental disorder</td>
<td>Symptoms in criterion B cause clinically significant distress or impairment in functioning</td>
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<tr>
<td>292.89  Caffeine-Induced Anxiety Disorder</td>
<td>Prominent anxiety, panic attacks, or obsessions or compulsions predominate [A predominant disturbance in sleep that is severe enough to warrant medical attention]</td>
<td>Evidence from history, physical exam, or lab values that 1) the symptoms in A developed during or within one month of caffeine intoxication and withdrawal; or 2) medication use is related to the disturbance</td>
<td>Disturbance not better accounted for by an Anxiety [Sleep] Disorder; evidence includes the following: symptoms precede caffeine use, symptoms occur for at least a month after the cessation of withdrawal or intoxication or substantially in excess of normal amount of caffeine or evidence suggesting an independent Anxiety [Sleep] Disorder</td>
<td>Disturbance does not occur exclusively during a delirium</td>
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(American Psychiatric Association, 2000; James, 1997)
The manual also has entries on caffeine dependence and abuse; excessive use may also be tied to Mood, Eating, Psychotic, Sleep and Substance-Related Disorders (American Psychiatric Association, 2000; James, 1997).

**Caffeine and reproduction.** Caffeine has been to blame in women for shortened menstrual cycles, reduced conception, and delayed implantation (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Spiller, 1998). It has also been studied as a threat to pregnancy and the developing fetus, culminating in 1980 with the FDA’s warning to pregnant women to eliminate or restrict coffee consumption to about 2 cups or 200 mg of caffeine or less per day (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Weinberg & Bealer, 2001). As a result, further studies have been done that support this warning.

During pregnancy, the half-life of caffeine increases from five hours to 18 hours. Caffeine crosses the placenta and the fetus is unable to metabolize it, thus depends on the mother to eliminate the compound ( Heckman, Weil, & Gonzalez de Mejia, 2010; James, 1997; Weinberg & Bealer, 2001). Caffeine has also been shown to cause teratogenic effects in rodents, not limited to missing digits, cleft palate, and skeletal deformities (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998). The calculated human dose of caffeine to cause a similar effect is the equivalent of 35 cups of moderately strong coffee. As these effects have not been studied in humans, the margin of error on these findings is unknown. There is a strong causal relationship between caffeine intake in pregnancy and a lower birth weight as well (James, 1997; Spiller, 1998). No significant associations have been found with caffeine
and preterm delivery, and moderate associations have been found with caffeine and spontaneous abortion in the first trimester of pregnancy (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Stickgold & Walker, 2009; Weinberg & Bealer, 2001).

Looking at newborn health, maternal caffeine consumption has been proven to impair the development of sound teeth in mice (James, 1997). Newborns may also suffer from caffeine withdrawal at birth (James, 1997; Weinberg & Bealer, 2001). Lastly, caffeine may exacerbate other teratogenic agents the mother may encounter during pregnancy (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997).

**Caffeine and cancer.** Examining cells in vitro has shown the mutagenic potential of caffeine, but looking at animals in vivo has proven that caffeine is not a carcinogen, is antitumoric under some conditions, and is carcinogenic under other conditions (James, 1997). Aside from various other factors like smoking, diet, and gender, there are weak correlations between coffee consumption and bladder and pancreatic cancers (James, 1997; Spiller, 1998; Wilson & Temple, 2004). Conversely, there is a weak protective effect of caffeine against colon cancer. These effects could also be due to other constituents aside from caffeine, such as the anticarcinogenic effect of polyphenols in tea (James, 1997).

**Caffeine and mood.** Caffeine has also been known to negatively impact mood at doses of 500 mg or more (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001). Dysphoric effects like anxiety, tension, hostility, and jitteriness are
common (Institute of Medicine (U.S.). Committee on Military Nutrition Research, 2001; James, 1997; Weinberg & Bealer, 2001). In extreme cases, caffeine can induce a psychosis when too much has been consumed. This includes hallucinations and extreme distress (James, 1997). Caffeine also potentiates the effects of stress (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Wilson & Temple, 2004).

Caffeine is also thought to be involved in depressive disorders, as moderate to high intake is often seen in depressed patients (James, 1997; Weinberg & Bealer, 2001). It has also been suggested that caffeine is used to “self-medicate” in certain groups during depressive periods (James, 1997; Weinberg & Bealer, 2001). Caffeine has been reported to increase aggression, and in one study, increased scores on the Profile of Mood States (POMS) Questionnaire (James, 1997; Weinberg & Bealer, 2001). In another study, caffeine was used and abused by students with high aggressive tendencies (Egbochuku, 2007).

**Caffeine and miscellaneous diseases.** Caffeine has been negatively associated with a wide assortment of other ailments, including increased risks for type I diabetes mellitus in children, multiple sclerosis, and lower extremity arterial disease in elderly women (James, 1997). Caffeine has also been studied in psychiatric patients that consume twice the amount of caffeine than nonpatients; caffeine has been shown to exacerbate schizophrenia as well as depersonalization disorder (James, 1997).

Caffeine at high intakes is also seen in those afflicted with eating disorders as a way to suppress appetite. Black coffee and diet cola in high quantities maintains energy
with virtually no calories and increases the body’s metabolic rate. Caffeine intake is thought to increase as the severity of symptoms increases (James, 1997).

**Caffeine and the harm of soft drinks.** With the explosive increase of soft drink consumption in the United States, Americans are getting an additional seven teaspoons of sugar daily just from their soft drink consumption (Wilson & Temple, 2004). This increase also shows an increase in caloric intake, risk of obesity, risk of osteoporosis, dental caries, risk of heart disease, insulin resistance, and caffeine intake. For young children who do not consume caffeine, this can cause restlessness, sleep difficulties, and headaches. When children stop drinking these beverages, their academic performance suffers (Wilson & Temple, 2004).

**Tools to Track Caffeine Intake**

There are several tools to quantify how much caffeine an individual consumes. The Caffeine Consumption Questionnaire (CCQ) was designed to precisely measure self-reported weekly caffeine use. Its original application was to tie caffeine use to personality in college students. Items on the questionnaire have specific time periods throughout the day: morning (6 am – 12 noon), afternoon (12 noon – 6 pm), evening (6 pm – 2 am), and night (2 am – 6 am). Caffeine food, drug, and beverage items also have specified serving sizes and caffeine amounts per serving, so that all measures are standardized (Landrum, 1992). Shohet and Landrum updated the CCQ to test college students again in 2001. These updates include more caffeinated products and improved time of day preferences (Landrum, 1992; Shohet & Landrum, 2001). The questionnaire was used alongside the Morningness-Eveningness Questionnaire (MEQ) to better
describe patterns of caffeine use in college students (Horne, 1976; Shohet & Landrum, 2001). Being used with college students and having a consistent measure, the CCQ is still a quick-scoring tool to assess weekly caffeine consumption.

The Stanford Caffeine Questionnaire (SCQ) was created to measure the interactions of sleep and caffeine in college students. A wrist actigraph was used to measure sleep in participants with this questionnaire, and caffeine content was measured via salivary swab (Nova, Hernandez, Ptolemy, & Zeitzer, 2012). This survey was based on the CCQ by Landrum, with updated research on caffeine products, additional caffeine categories, and six-hour blocks that were based on the student’s specific schedule (Landrum, 1992; Nova, Hernandez, Ptolemy, & Zeitzer, 2012). While this survey was specifically designed to go along with work on a single nucleotide polymorphism (SNP) on the adenosine 2A receptor gene, the modifications to the CCQ instrument are an appropriate update for the current collegiate population (Nova, Hernandez, Ptolemy, & Zeitzer, 2012).

The Caffeine Expectancy Questionnaire (CEQ) focuses more on the psychological aspects of caffeine consumption. It is the first questionnaire of its kind, modeled after the Cocaine Effect Expectancy Questionnaire (CEEQ), Stimulant Effect Expectancy Questionnaire (SEEQ), and the DSM IV-TR (Heinz, Kassel, & Smith, 2009). The CEQ is a 37-item questionnaire with a four-point agreement scale. There are four different areas that it covers include withdrawal symptoms, positive effects, acute negative effects, and mood effects (Heinz, Kassel, & Smith, 2009). It does not take into consideration caffeine’s impact on sleep, performance or weight control behaviors.
(Huntley & Juliano, 2011). It assesses caffeine intake based on the amount of days an individual had caffeine in the past week as well as the number of servings of each food or beverage class for that week, but does not include energy drinks (Heinz, Kassel, & Smith, 2009; Huntley & Juliano, 2011). Overall, this questionnaire is based on perceptions and expectations of the drug’s use (Heinz, Kassel, & Smith, 2009). A similar questionnaire by Bradley and Petree concerning the behavioral effects of caffeine in college students measured expectancies of enhanced performance (EP-CAFF), total caffeine consumption (TCAFF), symptoms of caffeinism as described in the *DSM-III* (CAFF-SX), as well as alcohol and tobacco usage (1990). This questionnaire used the caffeine values per serving of foods and beverages in the *DSM-III* as a standard, which do not account for the wide array of caffeinated products on the market today (Bradley & Petree, 1990).

**Caffeine Trends in College Students**

College students have an unpredictable schedule, with work, school, a social life, and sometimes even family obligations; sleep deprivation is common in this population as a result (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). Caffeine use is widespread; one study by Shohet and Landrum found that not one student was caffeine free (2001). While 22% of students currently smoke cigarettes, and 50% have had at least one alcoholic drink in the past month, 89% consumed caffeine in the past month (Norton, Lazev, & Sullivan, 2011).

**Caffeine Uses in College Students**

In a study by Attila, 54.9% of students surveyed had irregular sleep patterns (2011). Likewise, the American College Health Association reported that 71% of college
students did not feel rested in five of the past seven days (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). Students consume caffeine with meals (34%) and on a daily basis (33%); students tend to keep a consistent caffeine use to perhaps both combat sleepiness and keep on a stable track of performance (Norton, Lazev, & Sullivan, 2011).

Age is a large factor determining caffeine use (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). Older students consume more caffeine than younger students, perhaps due to an increased workload (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). Senior-level students have been reported to consume an average of 1698.02 mg of caffeine per week, in contrast to freshmen with 1106.23 mg of caffeine weekly (Norton, Lazev, & Sullivan, 2011).

Caffeine use in college students also has some interesting and not interrelated data. Both males and females reported rarely avoiding caffeine (Johnson-Greene, Fatis, & Shawchuck, 1988). The most frequent caffeine consumption has been seen on Mondays (28%) and Fridays (38%) versus the rest of the week; over 61% of students consumed caffeine on Saturdays, and 49% consumed caffeine on Sundays (Loke, 1988). Often, men consume more caffeine to mix with alcohol and for long drives (Arria, Caldeira, Kasperski, Vincent, Griffiths, & O'Grady, 2011; Attila & Cakir, 2011; Norton, Lazev, & Sullivan, 2011). Lastly, only 4% of students use caffeine to supplement exercise as an ergogenic aid (Norton, Lazev, & Sullivan, 2011).

In 67% of students, caffeine consumption is heavily increased when preparing for examinations (Loke, 1988). In a study by Norton et al., 26% of students used caffeine
very often to study for exams, and 27% used these products to work on school projects (2011). In extreme cases, some students may consume five to six energy drinks per “situation,” or about 4%. This supports the idea that as energy drink consumption decreases, academic performance increases, with no room for procrastination (Pettit & DeBarr, 2011). Caffeine consumption was shown to have a positive relationship with academic performance in one study by Loke (1988). About one third of students felt caffeine helped them to study longer, whereas about 6% of students felt that they could study more efficiently (Loke, 1988).

Caffeine Sources Used By College Students

A study by Norton et al. found that 98% of students had ever consumed caffeine (Norton, Lazev, & Sullivan, 2011). A 1988 study found that coffee was the top caffeine source in college students; coffee was primarily enjoyed in the morning, whereas tea and soft drinks were consumed in the evening (Loke, 1988). Soft drinks are the most frequently consumed caffeinated product in 81% of students, yet not the product that the highest amounts of caffeine are obtained from in this group (Norton, Lazev, & Sullivan, 2011). Coffee, lattes, and espresso drinks are the bulk of students’ caffeine consumption, yet only 41% of students have coffee in a given week (Norton, Lazev, & Sullivan, 2011). Additionally, 42% had consumed energy drinks in the past month and 29.1% of students had consumed an energy drink the day before the study (Norton, Lazev, & Sullivan, 2011; Pettit & DeBarr, 2011). Men consume more caffeine than women do, in respect to energy drinks and energy shots, with 424.02 mg of men’s total weekly caffeine coming from these sources versus 216.05 mg for women; men obtain more caffeine from soft
drinks as well, with 523.33 mg of their total weekly caffeine from this source compared to 421.75 mg for women (Norton, LaZeV, & Sullivan, 2011; Pettit & DeBarr, 2011). Men consumed more energy drinks on average in larger quantities and more often perhaps due to risk-taking behavior and conformity to masculine norms (Pettit & DeBarr, 2011).

**Reasons Why Energy Drinks are Used by College Students**

Energy drinks have been found to improve reaction times, alertness, and prevent sleep (Attila & Cakir, 2011). They are easy to access and are used frequently. A study by Attila and Cakir found that 48.3% of students have tried energy drinks at least once (2011). Students consume these products out of curiosity, for energy, and to boost performance. Other reasons for energy drink use include for studying, long drives, to treat a hangover, and to mix with alcohol (Attila & Cakir, 2011). In a study by Malinauskas et al., 50% of users drank an energy drink to study, while 17% used one to treat a hangover (2007). Energy drinks are preferred over other beverages to feel “energetic,” and for concentration (Attila & Cakir, 2011). Over two thirds of users consume energy drinks to stay awake (Attila & Cakir, 2011; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007).

Energy drinks are used by 37.2% to up to 50% of students to improve the taste of alcohol when partying (Attila & Cakir, 2011; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). This finding supports the FDA’s declaration that caffeine is an ‘unsafe food additive’ to alcoholic beverages, which spawned the banning of premixed alcoholic energy drinks in November 2010 (Wolk, Ganetsky, & Babu, 2012). In other countries, this percentage can vary from 48.4%-87.6% of students (Attila &
Cakir, 2011). Combining alcohol and energy drinks results in the use of drinking three or more energy drinks in a given episode in over half of users (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). This is dangerous due to the depressant effects of alcohol, making it unclear the degree of intoxication, as well as disguising the point when too much alcohol has been consumed (Arria, Caldeira, Kasperski, Vincent, Griffiths, & O'Grady, 2011; Attila & Cakir, 2011). Reasons why this practice is so popular include the ability to drink more and the sensation of being in control (Wolk, Ganetsky, & Babu, 2012). In addition, vomiting, respiratory depression, and severe dehydration can occur with energy drink and alcohol consumption (Attila & Cakir, 2011). This combination also causes increased aggression, hangover, difficulty inhibiting oneself, and even puts one at risk for alcohol dependence (Arria, Caldeira, Kasperski, Vincent, Griffiths, & O'Grady, 2011; Attila & Cakir, 2011; Wolk, Ganetsky, & Babu, 2012).

Only a third of students that consume energy drinks regularly know what ingredients are in them. A common misconception is that energy drinks are the same as sports drinks (Attila & Cakir, 2011). About half of students know the health effects of energy drinks (Attila & Cakir, 2011; Loke, 1988). One study found that female caffeine consumers are more likely to seek out information about caffeine and its effects as well as to report consumption (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). Over 90% of students are not aware of the effects of energy drinks on the heart (Attila & Cakir, 2011).

Students have been found to continue using caffeine in light of insomnia, fatigue,
stomach problems, jolt and crash episodes, heart palpitations, and muscle tremors (Johnson-Greene, Fatis, & Shawchuck, 1988; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). This can be attributed to a lack of awareness of caffeine’s action on the body as well as the individual not knowing how the drug and their body interact (Johnson-Greene, Fatis, & Shawchuck, 1988). It has been found that energy drinks specifically also increase the risk of hepatitis, acute renal failure, seizures, subarachnoid hemorrhages, and cause anxiety (Wolk, Ganetsky, & Babu, 2012).

Students had higher levels of perceived stress on days they consumed energy drinks in a study by Pettit and DeBarr (2011). It is clear that there is not enough energy drink, or even caffeine education for students (Attila & Cakir, 2011).
CHAPTER III

METHODOLOGY

Design

The study design was a comparative, 2X5X8 Factorial ANOVA with two levels of gender (male, female), five levels of type of consumer (non-caffeine consumer, low caffeine consumer, moderate caffeine consumer, high caffeine consumer and very high caffeine consumer) and eight levels of residence location status (single dorm room, double dorm room, triple dorm room, quad dorm room, off-campus studio/1-bedroom apartment, off-campus 2-bedroom apartment, off-campus 3-bedroom apartment, and off-campus 4+-bedroom apartment/house). Independent variables were gender, residence location, and caffeine consumer status, with total caffeine intake being an independent variable when looking at sleep duration. Dependent variables were the total caffeine intake from beverages and foods (mg caffeine) when looking at gender or residence status, and the duration of sleep.

Sample

Participants were recruited via convenience sample of university students based on current enrollment for the Spring 2013 semester. Out of the 29,378 students contacted, the response rate was 20.24% (n=5947). Students were included in accordance with the study definition of student: any male or female undergraduate student that was presently in the Kent State University campus system, currently enrolled full time (12 credits or more/semester), was between the ages of 18-24, and was not a
parent. Exclusion criteria included graduate students, students taking less than a full course load, students from other universities, students younger than 18 or older than 24, and students with children. Additional exclusion criteria included currently living with parents at home and taking two or more naps per day. Multiple naps were excluded as they suggest an abnormal discontinuous sleep pattern or a symptom of a sleep disorder. Of the students contacted, 8.96% met survey criteria (n=2,632) and 8.19% of that data was complete (n=2407).

**Measures**

An online Caffeine Consumption and Sleep Questionnaire with three sections was utilized. The questionnaire was developed based on the Caffeine Consumption Questionnaire (CCQ) created by R. E. Landrum (1992). The researcher added updates on new energy and coffee drinks not originally included. The survey was available to students through the Survey Monkey survey creation website online.

Eight questions were in Part I of the survey to gather demographic information about participants, ensure inclusion criteria, and to classify independent variables. The question on location of residence included an option for the exclusion criteria of living at home with parents.

The caffeine portion of the survey, or Part II, listed products in the groupings of coffee, coffee-shop coffees, popular brand coffees, coffee beverages, espresso, teas, hot cocoa/chocolate, soft drinks, over the counter drugs, energy drinks/shooters, and other foods. Participants completed this section by checking a box next to only the products that they consumed on the survey, indicating that they consumed 1, 2, 3, 4, 5, or 6+
servings of that item per day.

The different caffeine consumer categories were defined as follows: non-caffeine consumer, 0-20 mg total; low caffeine consumer, 21-100 mg total; moderate caffeine consumer, 101-300 mg total; high caffeine consumer, 301-1000 mg total; very high caffeine consumer, ≥1001 mg total. Categories were created based on natural breaks in the survey data; non-consumer status was determined by items not typically consumed for their caffeine content (i.e. chocolate candy bars) while very high caffeine consumer status used any total intake after the 1 gram threshold for intoxication symptoms. Total caffeine content data (mg) was derived from the single day’s total caffeine intake from the foods and beverages indicated on the survey.

The sleep portion of the survey, or Part III, consisted of eight questions. There was a question concerning average sleep in a 24-hour period and three questions on the frequency and duration of naps. The question on the number of naps was also testing exclusion criteria, if the participant reported taking two or more naps. Questions gave the option of “AM” and “PM” classification to cover students with less traditional sleep schedules. There were two questions asking what times participants woke up at during the week as well as what times they went to bed. Two more questions looked at rise times and bed times on weekend days.

Procedure

The project was approved by the Kent State University Institutional Review Board (IRB). Permission was then granted to have access to undergraduate student emails through the University Registrar’s office. The survey material was entered into
the SurveyMonkey online survey-creation platform and an access link was emailed out to students.

Upon clicking the email link and entering the survey, if a participant selected responses that were not in accordance with the study’s “student” definition, took two or more naps daily, or lived at home with their parents, upon clicking “next” they saw an end screen thanking them for participating in the survey.

The survey was accessible from late February to late March, 2013, with a reminder email sent out after one week to both remind students to complete the survey as well as to advertise an incentive. A grant was received to fund three, $100.00 Amazon.com e-gift cards to increase participation rate, which were awarded by SurveyMonkey upon closure of the survey. Demographics collected through the prize sweepstakes entry form were separate from and were not connected to the Questionnaire data, and prize selection and distribution were handled in full by SurveyMonkey to maintain anonymity. Responses were collected after one month’s time on March 29, 2013 and data were summarized.

**Data Analysis**

Demographic information, sums of total caffeine consumption for a 24-hour period, and sleep recall numbers were entered into the SPSS statistical software package (SPSS version 20.0, IBM). A multifactorial ANOVA was calculated with two levels of gender (male, female), five levels of participants’ total caffeine intake status (non-caffeine consumer, low caffeine consumer, moderate caffeine consumer, high caffeine consumer and very high caffeine consumer) and eight levels of residence location status.
(single dorm room, double dorm room, triple dorm room, quad dorm room, off-campus studio/1-bedroom apartment, off-campus 2-bedroom apartment, off-campus 3-bedroom apartment, and off-campus 4+-bedroom apartment/house). Post hoc analysis using Bonferroni significance was performed for all significant analyses and to ensure validity between groups. Caffeine intake based on participants’ intake selections was downloaded into a spreadsheet from Survey Monkey, summed, and ordered for analysis. A priori significance was determined at $p \leq 0.05$. 
CHAPTER IV
JOURNAL ARTICLE

Introduction

Humans spend about one third of their lifetime asleep (Reinoso-Suarez, de Andrés, & Garzón, 2011). It is still debatable about how sleep works, but it is essential to all forms of life and their survival. In general, adults need about seven to eight hours of sleep per day (Chaput, Després, Bouchard, & Tremblay, 2008). Some broader recommendations for college students specifically state that six to nine hours of sleep per day is optimal for proper functioning; at anything less than seven hours per day, individuals are at risk for an increased mortality as well as weight gain (Chaput, Després, Bouchard, & Tremblay, 2008; Hublin, Partinen, Koskenuvo, & Kaprio, 2007).

College students often have restricted and irregular sleep (Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997). From 7.5 hours of sleep per night in 1969 to 6.5 hours in 1989, this population continues to lose sleep (Brown, Buboltz, & Sopher, 2002). College students have poor sleep quality and sleep satisfaction, increasingly worsened by academic year in school (Eliasson, Lettieri, & Eliasson, 2010; Liguori, Schuna, & Mozumdar, 2011). Sleep quality can also be associated with academic progress, illness, social activities, stress, and living conditions (Lund, Reider, Whiting, & Prichard, 2010; Veldi, Aluoja, & Vasar, 2005). Dependence on the consumption of caffeine as well as alcohol consistently equates to poor sleep hygiene (Brown, Buboltz, & Sopher, 2002; Lund, Reider, Whiting, & Prichard, 2010; Sweileh,
Caffeine is the world’s most popular drug, consumed for a wide variety of reasons. Habitual consumers eat and drink caffeine because it makes them feel better, gives them more energy, helps them relax, and is refreshing, while others consume caffeine to stay awake, increase athletic performance, or to lose weight (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). Caffeine is metabolized quickly because of its water solubility, and is transported amongst all body tissues and secretions equally, from breastmilk to saliva and semen (Chambers, 2009; James, 1997; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). The concentrations of caffeine in the body rely on a multitude of factors and the drug’s half-life varies from two to up to nine and a half hours (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Weinberg & Bealer, 2001).

The consumption of caffeine to reap its benefits or to suffer its consequences depends on the task at hand and the dose consumed (James, 1997; Schellack, 2012). The current FDA recommendation on caffeine is 400 mg per day for adults with no recommendation for adolescents or children (United States Food and Drug Administration, 2013). Benefits of caffeine usage include increases in athletic performance, work, cognitive functioning, and weight loss (Doan, 2006; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller,
However, caffeine offers some substantial dangers and it is still debatable if caffeine is safe long-term. Heart function, bone health, reproduction, cancer, and mood are all compromised with excess caffeine intake (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Spiller, 1998; Stickgold & Walker, 2009; Weinberg & Bealer, 2001). High consumption of caffeine also has detrimental effects, from dependence and withdrawal to psychological disorders such as caffeinism and even death (American Psychiatric Association, 2000; James, 1997).

Today, American adults consume an average of 200 mg caffeine daily (Norton, Lazev, & Sullivan, 2011; Shohet & Landrum, 2001; Weinberg & Bealer, 2001). However, age is a large factor determining caffeine use, seen by both the marketing targeted to young adults as well as the late night lifestyle seen in this population (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). A study by Norton et al. found that 98% of college students had ever consumed caffeine, making it the most popular substance on campuses with an average of 1106.23-1698.02 mg per week, increasing with year in school (Norton, Lazev, & Sullivan, 2011). One study by Shohet and Landrum found that not one student surveyed (n=691) was caffeine free (2001). Adding to this the removal of parents from a teen’s life, sleep as well as caffeine intake may have no moderation whatsoever in this population.

The purpose of this comparative study was to determine if there are differences in caffeine consumption in gender as well as residence status and sleep differences in high caffeine consumers versus low caffeine consumers at a public, Midwestern university. In
the present study, the research hypothesis was that there would be a difference between genders, residence status, and sleep with caffeine consumption, with on-campus students expected to consume more caffeine and high caffeine consumers expected to sleep less than their peers.

Additionally, college students are a unique population to study, due to the inconsistency of their daily schedule and unique stressors. College students have been studied in relation to both sleep data and caffeine intakes, but never before has a study tried to integrate both factors of collegiate life.

**Methodology**

**Design**

The study design was a comparative, 2X5X8 Factorial ANOVA with two levels of gender (male, female), five levels of type of consumer (non-caffeine consumer, low caffeine consumer, moderate caffeine consumer, high caffeine consumer and very high caffeine consumer) and eight levels of residence location status (single dorm room, double dorm room, triple dorm room, quad dorm room, off-campus studio/1-bedroom apartment, off-campus 2-bedroom apartment, off-campus 3-bedroom apartment, and off-campus 4+-bedroom apartment/house). Independent variables were gender, residence location, and caffeine consumer status, with total caffeine intake being an independent variable when looking at sleep duration. Dependent variables were the total caffeine intake from beverages and foods (mg caffeine) when looking at gender or residence status, and the duration of sleep.
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Results

A convenience sample of 5,947 students participated in the survey, yet only 2,632 respondents met survey criteria. After accounting for incomplete data and severe caffeine outliers (over male fatal dose of 5 g), 2,407 participants were included for analysis.

Subject Characteristics

Table 3 depicts the demographic data of the 2,407 participants. The majority of the population was female (72.9%, n=1755), attended classes at the Kent main
campus (92.7%, n=2232), and lived in a double dorm room on campus (31.9%, n=769).

Table 3. *Demographic Data of Respondents Completing the Caffeine Consumption and Sleep Questionnaire (n=2407)*

<table>
<thead>
<tr>
<th>Demographic</th>
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<th>%</th>
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<tr>
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<td>19</td>
<td>0.8</td>
</tr>
<tr>
<td>Stark</td>
<td>68</td>
<td>2.8</td>
</tr>
<tr>
<td>Trumbull</td>
<td>20</td>
<td>0.8</td>
</tr>
<tr>
<td>Tuscarawas</td>
<td>26</td>
<td>1.1</td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Dorm Room</td>
<td>179</td>
<td>7.4</td>
</tr>
<tr>
<td>Double Dorm Room</td>
<td>769</td>
<td>31.9</td>
</tr>
<tr>
<td>Triple Dorm Room</td>
<td>74</td>
<td>3.1</td>
</tr>
<tr>
<td>Quad Dorm Room</td>
<td>58</td>
<td>2.4</td>
</tr>
<tr>
<td>Off campus Studio/1 Bedroom Apartment</td>
<td>207</td>
<td>8.6</td>
</tr>
<tr>
<td>Off campus 2 Bedroom Apartment</td>
<td>474</td>
<td>19.7</td>
</tr>
<tr>
<td>Off campus 3 Bedroom Apartment</td>
<td>221</td>
<td>9.2</td>
</tr>
<tr>
<td>Off campus 4+ Bedroom or House</td>
<td>425</td>
<td>17.7</td>
</tr>
</tbody>
</table>

% = percentage as defined by frequency

**Significant Differences in Caffeine Consumption Patterns**

Table 4 examines the distribution of the different caffeine consumer groups and the means and standard deviations of each groups’ total caffeine consumption. Groups were set by mean caffeine intakes. Most participants fell into the high caffeine consumer group (39.5%, n=951). The very high caffeine consumer group had the highest mean of caffeine consumed per day (1646.52 ±573.99 mg). There were significant differences in caffeine intake between the caffeine consumer groups, overall (p = 0.001).
Table 4. Significant Differences of Caffeine Consumption by Consumer Group

<table>
<thead>
<tr>
<th>Consumer Group</th>
<th>n</th>
<th>%</th>
<th>Mean ± Standard Deviation (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-caffeine consumer a,b,c</td>
<td>162</td>
<td>6.7</td>
<td>4.03 ± 17.36</td>
</tr>
<tr>
<td>Low caffeine consumer d,e,f</td>
<td>251</td>
<td>10.4</td>
<td>58.92 ± 26.90</td>
</tr>
<tr>
<td>Moderate caffeine consumer a,d,g,h</td>
<td>400</td>
<td>16.6</td>
<td>204.20 ± 130.37</td>
</tr>
<tr>
<td>High caffeine consumer h,c,g,i</td>
<td>951</td>
<td>39.5</td>
<td>630.25 ± 203.98</td>
</tr>
<tr>
<td>Very high caffeine consumer c,f,h,i</td>
<td>643</td>
<td>26.7</td>
<td>1646.52 ± 573.99</td>
</tr>
</tbody>
</table>

% = percentage as defined by frequency
a-i Like letters show Post Hoc significant differences (p≤0.05)

There was no significant difference between total caffeine consumption between males and females (694.63 ± 693.78 and 742.05 ± 676.29 mg respectively, p=0.956).

Consumer groups had significant differences in their total sleep (p=0.001), napping (p=0.05), and nap quantity for an average day (p=0.007). Post Hoc Analyses were not calculated because this was not a central piece of the investigation.

Overall, no significant difference exists between living situation and total caffeine consumption (p = 0.140). The only significant total sleep difference between living situation was double dorm room residents and off-campus 4+ bedroom apartment/house residents (p=0.034). Overall, bedtimes during the week (p=0.007) and wake times on the weekend (p=0.015) were also significantly different by living situation. Since this was not a major objective of the study, Post Hoc Analysis was not computed.

Significant Differences in Sleep Patterns

Figure 1 depicts the significant differences in sleep by caffeine consumer status (p=0.001). The very high caffeine consumer group had the lowest mean of sleep over a 24-hour period versus the non-caffeine consumer group (mean =6.75 hours versus 7.54 hours, respectively). Examining the differences in the relationship between two caffeine
consumer groups at a time and the total hours of sleep that each group obtained, there were significant differences with the high caffeine consumer group and both non-caffeine consumers and low caffeine consumers \((p=0.003\) and \(p=0.016\), respectively). There were also significant differences between the very high caffeine consumers and: non-caffeine consumers \((p=0.001)\), low caffeine consumers \((p=0.001)\), moderate caffeine consumers \((p=0.001)\), and high caffeine consumers \((p=0.001)\).

Figure 1: Mean hours of sleep for a 24-hour period for all caffeine consumer groups

\(^a\)Like letters show significant differences \(p \leq 0.05\)
\(^1\)Non-consumer: Consumes 0-20 mg caffeine total per day
\(^2\)Low consumer: Consumes 21-100 mg caffeine total per day
\(^3\)Moderate consumer: Consumes 101-300 mg caffeine total per day
\(^4\)High consumer: Consumes 301-1000 mg caffeine total per day
\(^5\)Very High consumer: Consumes ≥1001 mg caffeine total per day
Discussion

The purpose of this study was to examine caffeine intake and sleeping habits among undergraduates in the Kent State University system. The study results indicated:

1) no significant difference in males and females in regards to total caffeine consumption; thus, the first part of the hypothesis was rejected;
2) no significant differences in on-campus and off-campus students in regards to total caffeine consumption; thus, the second part of the hypothesis was rejected;
3) overall, high caffeine consumers do sleep less than low caffeine consumers. Thus, the third part of the hypothesis was accepted.

Caffeine Consumption Patterns

Comparing total caffeine consumption across all students in this study to some of the reviewed literature demonstrated a wide variation in total daily caffeine consumption in students, from 0-3482 mg of caffeine. There were students that did not consume caffeine at all, in likeness with the present study (Bradley & Petree, 1990; Landrum, 1992; Norton, Lazev, & Sullivan, 2011), whereas one study did not have a single caffeine-free participant at all (Shohet & Landrum, 2001). The present study had 123 students (5%) that consumed 0 mg of caffeine per day. This demonstrates that some of the previous research has overlooked non-caffeine consumers, and that caffeine consumption is not ubiquitous among college undergraduates.

On the other hand, very high caffeine intakes were also seen in this sample, with 643 students (26.7%) consuming 1001 mg or more of caffeine per day (mean = 1646.52±573.99 mg). While habituation, body size, and daily intake of caffeine vary from person to person, the symptoms of intoxication can progress further at one gram
79

(1000 mg) of caffeine, depending on tolerance. Aside from caffeine intoxication, a lethal dose of caffeine may range from 5-10 g for an adult male and involve convulsions, aspiration, or dysrhythmias (Alpert, 2012; American Psychiatric Association, 2000; Schellack, 2012).

**Gender.** Previous research has reported that both males and females rarely avoid caffeine, and that females were more conscious about what products contained caffeine (Johnson-Greene, Fatis, & Shawchuck, 1988). On the other hand, another study concluded that men consumed caffeine more to mix with alcohol as well as for long drives. Females were found to consume caffeine more during times of limited sleep (Attilla & Cakir, 2011; Norton, Lasev, & Sullivan, 2011). As the caffeine means between males and females were not significantly different in the current investigation, other factors may influence the rationale behind caffeine consumption between genders. For instance, factors such as body size influence how fast caffeine is metabolized, with smaller individuals needing less caffeine to reach the same effect equal to a larger individual. Additionally, males have a slower metabolism of caffeine than females, who can quickly metabolize the drug (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Weinberg & Bealer, 2001). Lastly, the caffeine timing throughout the day or the reasons for caffeine use, which were not researched in the present study, may better explain caffeine consumption between males and females.

**Living situation.** While the present study did not show significant differences overall in regards to caffeine consumption and living situation, previous investigations have determined living situation to negatively impact student sleep. Sleep patterns may
be affected by other factors; if present, roommates that snore, sleepwalk, or sleep-talk hurt the sleep of those around them by constantly waking them and depriving them of deep REM sleep. The sleep environment, with factors such as stress, social surroundings, and illness, impacts sleep quality (Lund, Reider, Whiting, & Prichard, 2010; Veldi, Aluoja, & Vasar, 2005). Social surroundings are often a large reason why students sleep less; over half surveyed stayed awake simply to socialize in one study, and over half surveyed in another study stayed up late at night to study and do assignments (Eliasson, Lettieri, & Eliasson, 2010; Liguori, Schuna, & Mozumdar, 2011). If a student has one or more roommates practicing either of these behaviors, their sleep may be disrupted as a result. While changing the environment can improve sleep, for those in apartment complexes or college dormitories this often is not a feasible solution (Brown, Buboltz, & Sopher, 2002; Gaultney, 2010).

Overall, when looking at both gender and residence location with caffeine use, the biggest question is if caffeine is causing students to sleep less, or if their sleep deprivation is causing them to consume more caffeine.

**Sleep Patterns**

Looking at the average hours of sleep per night through consumer type, both high caffeine consumers and very high caffeine consumers had an average of less than seven hours of sleep per night. For adults, seven to eight hours of sleep per night is recommended (Liguori, Schuna, & Mozumdar, 2011; Pilcher, Ginter, & Sadowsky, 1997; Sutton, 2005). Some broader recommendations state that six to nine hours of sleep per day is optimal for proper functioning in college students, but at anything less than seven
hours of sleep per day, individuals are at risk for increased mortality as well as weight gain (Chaput, Després, Bouchard, & Tremblay, 2008; Hublin, Partinen, Koskenuvo, & Kaprio, 2007).

The significant differences in sleep by consumer status could be attributed to several factors. Caffeine is a barrier to sleep, and its effects vary with regard to the individual, the timing of caffeine consumption, and drug habituation for daily consumers (Barkoukis, Matheson, Ferber, & Doghramji, 2012; Verster, Pandi-Perumal, & Streiner, 2008). The drug’s diuretic and anti-fatigue properties, coupled with its half-life of 2 - 9.5 hours can make sleeping nearly impossible (Chambers, 2009; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997). This may have been seen in the current investigation with the highest caffeine consumers sleeping the least.

A wide variety of academic, social, and personal factors make sleep restricted and irregular in college students as a whole (Lund, Reider, Whiting, & Prichard, 2010; Pilcher, Ginter, & Sadowsky, 1997). Perhaps these students are more apt to use caffeine to complete academic coursework and projects. One study by Loke found that in two-thirds of students, caffeine consumption was increased when preparing for examinations (1988). Depending on a student’s major, some academic programs do demand more frequent assessments. Another study by Norton et al. found that 27% of students used caffeine to work on school projects alone (2011). For students in programs such as architecture, art, or programs that are research-centered, projects could be a weekly occurrence. Age in school could also be heavily impacting caffeine use. While not examined in the present study, age is a large factor determining caffeine use; older
students consume more caffeine than younger students, perhaps due to an increased workload (Johnson-Greene, Fatis, & Shawchuck, 1988; Norton, Lazev, & Sullivan, 2011). Senior-level students have been reported from one study to consume an average of 1698.02 mg of caffeine per week, in contrast to freshmen with 1106.23 mg of caffeine weekly (Norton, Lazev, & Sullivan, 2011). Aside from the aforementioned reasons, decreased sleep and increased caffeine use also may have been attributed to the increased prevalence of night and online classes, as well as campuses keeping buildings such as libraries open later or even for twenty-four hours. Overall, the reasons behind student caffeine use may be a key component to both high and very high caffeine consumption.

High caffeine consumers and very high caffeine consumers are obtaining less than the recommended amount of sleep and are therefore at a higher risk for health consequences. When going without sleep, “sleep debt” accumulates; this must be replenished at whatever cost, usually at the expense of a person’s health (Lockley & Foster, 2012). Changes in mood and attentiveness can begin after just 36 hours and are most noticeable during typical sleep times, especially at four to six in the morning (Pollak, Thorpy, & Yager, 2010). Performance, awareness, and attention to detail are severely diminished (Cappuccio, Miller, & Lockley, 2010; Sutton, 2005). Physical manifestations of sleep deprivation may be present as well, including muscle weakness, tremors, and a lack of coordination (Pollak, Thorpy, & Yager, 2010). Overall, chronic sleep deprivation’s effects are just as damaging as those of acute sleep loss. Two weeks with less than six hours of sleep per night can make an individual’s performance equivalent to that to someone who has stayed up for 24 hours straight; this occurs in half
the time in someone who has slept four hours a night (Lockley & Foster, 2012).

High quantities of caffeine as well as consumption close to bedtime can also have detrimental effects, targeting high caffeine consumers as well as very high caffeine consumers. Too much caffeine may keep an individual awake for long periods of time, causing sleep deprivation. Short nights of sleep require “recovery sleep” and REM rebound over future days to replenish lost sleep (Pollack, Thorpy, & Yager, 2010). Declines in performance, mood, and an increased risk for health issues later on in life can all occur as a result of high caffeine consumption (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; James, 1997; Schellack, 2012).

Additionally, some of the very high caffeine consumers are at risk for caffeine intoxication or caffeinism, which could also be the root cause of their reduced sleep compared to their less-caffeinated peers. Caffeinism can occur around 3,100 mg of caffeine per day (Shohet & Landrum, 2001) or as little as 250 mg of caffeine if consumed in a very short period of time (American Psychiatric Association, 2000); with the drug tolerance leading up to this point, disrupted sleep is common. Any sort of caffeine withdrawal would induce sleepiness, headaches and decreased functioning, with caffeine being the only cure (James, 1997).

**Ancillary Data**

Data not central to the study objectives revealed that male students take more naps overall than female students. Coupled with differences in nap length, bedtimes during the week, and wake times on the weekends, genders at the collegiate level tend to sleep differently. While there are many factors that may affect sleep regardless of
gender, women are usually more sleep deprived and are less likely to have insomnia if sleeping with a significant other; men are more likely to snore and thus be at risk for sleep apnea, if snoring is frequent (Pollak, Thorpy, & Yager, 2010). One study also found that women had earlier average bedtimes and wake times versus men (Taylor & Bramoweth, 2010).

Application

Health has become an increasingly larger concern in society, especially relating to obesity. High consumption of soft drinks adds excess calories as well as high amounts of caffeine to a person’s daily intake. Caffeine use is highly prevalent in this population, as 95% of students in the present study consumed at least one product daily, something that universities need to acknowledge. Caffeine can curtail sleep by causing disturbances within the sleep-wake cycle; if consumed into mid-afternoon, it continues to act as an anti-fatigue agent as well as a diuretic throughout the late evening (Verster, Pandi-Perumal, & Streiner, 2008).

Seeing that sleep is crucial for proper metabolic function, this is another facet for health professionals to take into consideration for disease prevention and management (Stickgold & Walker, 2009). Disrupted or shortened sleep is associated with a negative energy balance, a tendency to favor more carbohydrates, an overall higher caloric intake, and an increased body mass index (BMI) (Chaput, Després, Bouchard, & Tremblay, 2008; Kathrotia, Rao, Paralikar, Shah, & Oommen, 2010; Lockley & Foster, 2012; Stickgold & Walker, 2009). An appropriate amount of sleep is also integral to college-aged students for final growth and development, critical thinking, problem solving skills,
mood, and working memory (Lockley & Foster, 2012; Stickgold & Walker, 2009).

As the present study’s findings demonstrate that high caffeine consumers sleep less than the other consumer groups, caffeine could be consumed to stay awake due to shortened overnight sleep and to remove feelings of fatigue. The shortened sleep intervals could be due to the caffeine not wearing off before the sleep period, making the individual not able to sleep.

In college curricula, sleep is often overlooked; therefore it is important to bring awareness to the issue of sleep deprivation and its consequences in this population. Universities could incorporate sleep hygiene presentations or speakers into a freshman seminar course or resident assistants could create a dorm education night to get this information out to students in all majors. Or, initiating a campus-wide health fair with a booth for sleep that has various screening tools and related information could better educate college students on this topic. While caffeine consumption may start at a younger age, education is also needed at the collegiate level about the effects of high caffeine intake on sleep. Similar methods of information dissemination would be appropriate, as both sleep and caffeine need to be taken more seriously in this population due to their negative consequences.

**Limitations**

To further improve the present study, perhaps collecting an average weekly caffeine intake would have given a better snapshot of student caffeine consumption because it would enable researchers to see trends of consumption by day as well as to see if binging with caffeinated products occurred. This method would also not rely on
students to think about an “average” day and would better delineate between weekday and weekend consumption. Additionally, asking questions surrounding caffeine usage and timing could lend more insight towards high and very high caffeine consumption.

**Conclusion**

This study confirmed that high and very high caffeine-consuming undergraduate college students sleep significantly less than their peers. Possibly more concerning, the students studied were on average classified as high caffeine consumers – drinking the equivalent of 6-7 cups of brewed coffee per day. This study also found that over one fourth of the students sampled consumed over 1000 mg of caffeine daily. The general public needs better education to thwart the lax attitudes towards caffeinated products and getting the proper amount of sleep; individuals need to be able to look beyond the trendiness of caffeinated beverages and foods, and need to step away from the 24/7 “always on” lifestyle, for maximum health and longevity. These findings also suggest that better education for students is needed in campuses on both sleep hygiene and the drawbacks of caffeine consumption to improve student well-being and prevent caffeine-related health issues in the future.
APPENDICES
APPENDIX A

CONSENT FORM
Appendix A

Consent Form

Welcome to "Assessment of Caffeine Consumption and Sleep in College Undergraduates," a web-based questionnaire that examines an average day’s caffeine intake and general sleeping habits in undergraduate students at Kent State University. Before taking part in this study, please read the consent form below and click on the "I Agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

This study involves a web-based questionnaire to examine an average day’s caffeine intake and general sleeping habits in undergraduate students at Kent State University. The study is being conducted by Christine Pfaff of Kent State University, a candidate for the Master of Science in Nutrition, and it has been approved by the Kent State University Institutional Review Board. No deception is involved, and the study involves no more than minimal risk to participants (i.e., the level of risk encountered in daily life).

Participation in the study typically takes 15 to 20 minutes and is strictly anonymous. Data will be collected through a series of questions including questions regarding personal demographics such as age, gender, KSU campus attended, and residence status, as well as questions on caffeinated food and beverage intake and a section of sleep recall. All data collected will be used for research purposes.

All responses are treated as confidential, and in no case will responses from individual participants be identified. Rather, all data will be pooled and published in aggregate form only. Participants should be aware, however, that the experiment is not being run from a "secure" https server of the kind typically used to handle credit card transactions, so there is a small possibility that responses could be viewed by unauthorized third parties (e.g., computer hackers).

Taking part in this research study is entirely up to you. You may choose not to participate or you may withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled.
If you have further questions or concerns about this research, you may contact Christine Pfaff at cpfaff1@kent.edu or Dr. Natalie Caine-Bish at ncaine@kent.edu. If you have any questions about your rights as a research participant or complaints about the research, you may reach the KSU Institutional Review Board at (330) 672-2704.

If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" button to begin the survey.

I Agree  I Do Not Agree
APPENDIX B

CAFFEINE CONSUMPTION AND SLEEP QUESTIONNAIRE
Appendix B

Caffeine Consumption and Sleep Questionnaire

Please answer honestly and to the best of your ability. Choose one answer for each question below:

**Part I: Demographics (Exclusion criteria*)**

Are you a current Kent State University student?  
Yes  No

Which campus do you currently take most of your classes at?

Ashtabula  East Liverpool  Geauga  Kent  Salem  Stark  Trumbull  Tuscarawas

Are you an Undergraduate level student?  
Yes  No

What is your age?  
Under 18  18-24  24+

Are you taking at least twelve (12) credit hours or more?  
Yes  No

Do you have any children?  
Yes  No
Please answer honestly and to the best of your ability. Choose one answer for each question below:

**Part I: Demographics (Independent variables)**

What is your gender: Male Female

Where do you live? Dorm

Check the residence type that best describes you:

Single Double Triple Quad

Off-Campus

Check the residence type that best describes you:

Studio/1 bedroom apartment Two bedroom apt. Three bedroom apt.

4+ bedroom apt. or house With parents*
Part II: Caffeine Consumption

Check the appropriate box, when applicable, indicating how many servings per average day you consume a particular substance.

(Note: Each highlighted area in Part II was on its own page in the electronic version of this survey, along with survey directions. Caffeine in mg was NOT visible to participants).

<table>
<thead>
<tr>
<th>Item</th>
<th>Caff. (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COFFEE (8 OZ SERVING)</strong></td>
<td></td>
</tr>
<tr>
<td>Brewed, percolated</td>
<td>176.0</td>
</tr>
<tr>
<td>Brewed, drip</td>
<td>240.0</td>
</tr>
<tr>
<td>Instant</td>
<td>106.0</td>
</tr>
<tr>
<td>Decaffeinated, brewed</td>
<td>7.2</td>
</tr>
<tr>
<td>Decaffeinated, instant</td>
<td>3.2</td>
</tr>
<tr>
<td>K-Cup Coffee (flavored coffees) for Keurig (8 oz)</td>
<td>120.0</td>
</tr>
<tr>
<td>K-Cup Coffee, Extra Bold (Highly Caffeinated) (8 oz)</td>
<td>150.0</td>
</tr>
<tr>
<td><strong>COFFEE SHOP COFFEES (SHEETZ, TREE CITY, DUNKIN' DONUTS, ETC.)</strong></td>
<td></td>
</tr>
<tr>
<td>12 oz coffee</td>
<td>199.5</td>
</tr>
<tr>
<td>16 oz coffee</td>
<td>266.0</td>
</tr>
<tr>
<td>20 oz coffee</td>
<td>332.5</td>
</tr>
<tr>
<td>12 oz latte</td>
<td>75.0</td>
</tr>
<tr>
<td>16 oz latte</td>
<td>150.0</td>
</tr>
<tr>
<td>20 oz latte</td>
<td>225.0</td>
</tr>
<tr>
<td>12 oz mocha</td>
<td>131.0</td>
</tr>
<tr>
<td>16 oz mocha</td>
<td>174.0</td>
</tr>
<tr>
<td>20 oz mocha</td>
<td>218.0</td>
</tr>
<tr>
<td><strong>POPULAR BRAND COFFEES</strong></td>
<td></td>
</tr>
<tr>
<td>Starbucks/Einstein's Coffee, Tall (12 oz)</td>
<td>260.0</td>
</tr>
<tr>
<td>Starbucks/Einstein's Coffee, Grande (16 oz)</td>
<td>330.0</td>
</tr>
<tr>
<td>Starbucks/Einstein's Coffee, Venti (20 oz)</td>
<td>415.0</td>
</tr>
<tr>
<td>Starbucks Latte/Macchiato, Tall (12 oz)</td>
<td>75.0</td>
</tr>
<tr>
<td>Starbucks Latte/Macchiato, Grande (16 oz)</td>
<td>150.0</td>
</tr>
<tr>
<td>Starbucks Latte/Macchiato, Venti (20 oz)</td>
<td>150.0</td>
</tr>
<tr>
<td>Starbucks Mocha, Tall (12 oz)</td>
<td>95.0</td>
</tr>
<tr>
<td>Starbucks Mocha, Grande (16 oz)</td>
<td>175.0</td>
</tr>
<tr>
<td>Starbucks Mocha, Venti (20 oz)</td>
<td>180.0</td>
</tr>
<tr>
<td>Caribou Coffee, small (12 oz)</td>
<td>230.0</td>
</tr>
<tr>
<td>Caribou Coffee, medium (16 oz)</td>
<td>307.0</td>
</tr>
<tr>
<td>Caribou Coffee, large (20 oz)</td>
<td>383.0</td>
</tr>
<tr>
<td>Caribou Coffee Latte, small (12 oz)</td>
<td>180.0</td>
</tr>
<tr>
<td>Caribou Coffee Latte, medium (16 oz)</td>
<td>180.0</td>
</tr>
<tr>
<td>Caribou Coffee Latte, large (20 oz)</td>
<td>270.0</td>
</tr>
<tr>
<td>Caribou Coffee Mocha, small (12 oz), all chocolates averaged</td>
<td>198.0</td>
</tr>
<tr>
<td>Caribou Coffee Mocha, medium (16 oz), all chocolate types avg</td>
<td>207.0</td>
</tr>
<tr>
<td>Caribou Coffee Mocha, large (20 oz), all chocolate types avg</td>
<td>305.0</td>
</tr>
</tbody>
</table>

**COFFEE BEVERAGES**

<p>| Starbucks Frappuccino Coffee bottle (9.5 oz) | 90.0 |
| Starbucks Frappuccino Dark Choc bottle (9.5 oz) | 115.0 |
| Starbucks Frappuccino Mocha bottle (9.5 oz) | 80.0 |
| Starbucks Frappuccino Vanilla bottle (9.5 oz) | 95.0 |
| Starbucks Doubleshot, any (15 oz) | 145.0 |
| Starbucks Doubleshot, any (6.5 oz) | 130.0 |
| Starbucks Blend Frappuccino Vanilla, Tall (12 oz) | 65.0 |
| Starbucks Blend Frappuccino Vanilla, Grande (16 oz) | 95.0 |
| Starbucks Blend Frappuccino Vanilla, Venti (20 oz) | 125.0 |
| Starbucks Blend Frappuccino Caramel/Coffee, Tall (12 oz) | 70.0 |</p>
<table>
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<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Starbucks Blend Frappuccino Caramel/Coffee, Grande (16 oz)</td>
<td>100.0</td>
</tr>
<tr>
<td>Starbucks Blend Frappuccino Caramel/Coffee, Venti (20 oz)</td>
<td>130.0</td>
</tr>
<tr>
<td>Starbucks Blend Frappuccino Mocha, Tall (12 oz)</td>
<td>70.0</td>
</tr>
<tr>
<td>Starbucks Blend Frappuccino Mocha, Grande (16 oz)</td>
<td>110.0</td>
</tr>
<tr>
<td>Starbucks Blend Frappuccino Mocha, Venti (20 oz)</td>
<td>140.0</td>
</tr>
<tr>
<td>ESPRESSO (1 OZ SERVING)</td>
<td></td>
</tr>
<tr>
<td>Espresso shot, single</td>
<td>75.0</td>
</tr>
<tr>
<td>TEAS (5 OZ SERVING)</td>
<td></td>
</tr>
<tr>
<td>White Tea (8 oz)</td>
<td>15.0</td>
</tr>
<tr>
<td>Green Tea (8 oz)</td>
<td>25.0</td>
</tr>
<tr>
<td>Black Tea (8 oz)</td>
<td>110.0</td>
</tr>
<tr>
<td>Chai Tea (8 oz)</td>
<td>47.0</td>
</tr>
<tr>
<td>Instant Tea (8 oz)</td>
<td>26.0</td>
</tr>
<tr>
<td>Other, not specified (8 oz)</td>
<td>72.0</td>
</tr>
<tr>
<td>COCOA &amp; CHOCOLATE PRODUCTS</td>
<td></td>
</tr>
<tr>
<td>Starbucks, any, tall hot cocoa (12 oz)</td>
<td>20.0</td>
</tr>
<tr>
<td>Starbucks, any, grande hot cocoa (16 oz)</td>
<td>25.0</td>
</tr>
<tr>
<td>Starbucks, any, venti hot cocoa (20 oz)</td>
<td>30.0</td>
</tr>
<tr>
<td>Other hot cocoa drink (8 oz)</td>
<td>21.0</td>
</tr>
<tr>
<td>Hershey Milk Chocolate bar (1.6 oz)</td>
<td>9.0</td>
</tr>
<tr>
<td>Hershey Special Dark bar (1.5 oz)</td>
<td>20.0</td>
</tr>
<tr>
<td>Other chocolate bars (1.55 oz)</td>
<td>9.0</td>
</tr>
<tr>
<td>Silk Chocolate Soymilk (8 oz)</td>
<td>4.0</td>
</tr>
<tr>
<td>Chocolate lowfat milk (8 oz)</td>
<td>5.0</td>
</tr>
<tr>
<td>Nesquik chocolate drink powder (.75 oz)</td>
<td>5.0</td>
</tr>
<tr>
<td>Chocolate syrup (2 T)</td>
<td>2.0</td>
</tr>
<tr>
<td>SOFT DRINKS (12 OZ SERVING)</td>
<td></td>
</tr>
<tr>
<td>Coca-Cola Classic, Cherry Coke (and Diet), Coke</td>
<td>34.0</td>
</tr>
<tr>
<td>Drink Description</td>
<td>Calories</td>
</tr>
<tr>
<td>--------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Zero, Vanilla Coke, Diet Coke with Splenda</td>
<td></td>
</tr>
<tr>
<td>Diet Coke (vanilla, lime, lemon, plus, original)</td>
<td>46.5</td>
</tr>
<tr>
<td>TAB</td>
<td>48.0</td>
</tr>
<tr>
<td>Mello Yello (and Diet version)</td>
<td>53.0</td>
</tr>
<tr>
<td>Mr. Pibb (and Diet version)</td>
<td>41.0</td>
</tr>
<tr>
<td>Dr. Pepper (and Diet version)</td>
<td>41.0</td>
</tr>
<tr>
<td>Pepsi Cola, Cherry Pepsi, Pepsi with Lime</td>
<td>38.0</td>
</tr>
<tr>
<td>Diet Pepsi, any</td>
<td>36.0</td>
</tr>
<tr>
<td>Pepsi MAX</td>
<td>69.0</td>
</tr>
<tr>
<td>Mountain Dew original, Baja Blast, Code Red, Ultra Violet</td>
<td>54.0</td>
</tr>
<tr>
<td>Diet Mountain Dew, Mountain Dew Voltage</td>
<td>55.0</td>
</tr>
<tr>
<td>Mountain Dew Game Fuel</td>
<td>72.0</td>
</tr>
<tr>
<td>RC Cola</td>
<td>46.5</td>
</tr>
<tr>
<td>Cherry RC Cola</td>
<td>43.0</td>
</tr>
<tr>
<td>Diet RC Cola</td>
<td>47.5</td>
</tr>
<tr>
<td>Faygo Cola</td>
<td>43.0</td>
</tr>
<tr>
<td>Shasta Cola</td>
<td>44.5</td>
</tr>
<tr>
<td>Big K Cola</td>
<td>39.0</td>
</tr>
<tr>
<td>Diet Big K Cola</td>
<td>31.0</td>
</tr>
<tr>
<td>Sam’s Cola (and Diet)</td>
<td>13.0</td>
</tr>
<tr>
<td>Big Fizz Cola</td>
<td>46.0</td>
</tr>
<tr>
<td>Diet Big Fizz Cola</td>
<td>62.0</td>
</tr>
<tr>
<td>A&amp;W Cream Soda</td>
<td>29.0</td>
</tr>
<tr>
<td>Barq’s Root Beer</td>
<td>23.0</td>
</tr>
<tr>
<td>Sunkist Orange Soda</td>
<td>41.0</td>
</tr>
<tr>
<td>OVER THE COUNTER DRUGS (1 tablet serving)</td>
<td></td>
</tr>
<tr>
<td>Vivarin</td>
<td>200.0</td>
</tr>
<tr>
<td>NoDoz Maximum Strength</td>
<td>200.0</td>
</tr>
<tr>
<td>Excedrin</td>
<td>65.0</td>
</tr>
<tr>
<td>Product</td>
<td>Price</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Vanquish</td>
<td>33.0</td>
</tr>
<tr>
<td>Anacin</td>
<td>32.0</td>
</tr>
<tr>
<td>Dristan</td>
<td>16.2</td>
</tr>
<tr>
<td>Midol</td>
<td>32.4</td>
</tr>
<tr>
<td>Dexatrim</td>
<td>200.0</td>
</tr>
<tr>
<td><strong>ENERGY DRINKS &amp; SHOOTERS</strong></td>
<td></td>
</tr>
<tr>
<td>Crystal Light Energy (1/2 packet)</td>
<td>60.0</td>
</tr>
<tr>
<td>MiO Energy, all flavors (1 squirt = 1/s teaspoon)</td>
<td>60.0</td>
</tr>
<tr>
<td>Spike Shooter (8.4 oz)</td>
<td>300.0</td>
</tr>
<tr>
<td>Cocaine (8.4 oz)</td>
<td>288.0</td>
</tr>
<tr>
<td>5 Hour Energy (1.93 oz)</td>
<td>207.0</td>
</tr>
<tr>
<td>Rip It (8 oz)</td>
<td>100.0</td>
</tr>
<tr>
<td>RedBull (any) (8.3 oz)</td>
<td>80.0</td>
</tr>
<tr>
<td>RockStar Original, Sugar Free (8 oz)</td>
<td>80.0</td>
</tr>
<tr>
<td>RockStar Original, Sugar Free, Recovery, Cola, Juiced (16 oz)</td>
<td>160.0</td>
</tr>
<tr>
<td>RockStar Original, Sugar Free (24 oz)</td>
<td>240.0</td>
</tr>
<tr>
<td>RockStar Zero Carb, Punched, Iced, Xdurance, Roasted (16 oz)</td>
<td>240.0</td>
</tr>
<tr>
<td>RockStar Zero Carb, Punched (24 oz)</td>
<td>360.0</td>
</tr>
<tr>
<td>RockStar 2x Energy (12 oz)</td>
<td>250.0</td>
</tr>
<tr>
<td>Monster hitman sniper snot (3 oz)</td>
<td>240.0</td>
</tr>
<tr>
<td>Monster, most varieties (16 oz)</td>
<td>160.0</td>
</tr>
<tr>
<td>Monster, low carb</td>
<td>140.0</td>
</tr>
<tr>
<td>Monster (24 oz)</td>
<td>240.0</td>
</tr>
<tr>
<td>Amp (16 oz)</td>
<td>142.0</td>
</tr>
<tr>
<td>Amp Sugar Free, Traction, Relaunch Lightning Charge, Elevate (16 oz)</td>
<td>160.0</td>
</tr>
<tr>
<td>Amp Black Tea (16 oz)</td>
<td>180.0</td>
</tr>
<tr>
<td>NOS (16 oz)</td>
<td>260.0</td>
</tr>
<tr>
<td>Full Throttle (8 oz)</td>
<td>72.0</td>
</tr>
<tr>
<td>Item</td>
<td>Price</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Full Throttle (16 oz)</td>
<td>144.0</td>
</tr>
<tr>
<td>Starbucks Refreshers (12 oz)</td>
<td>50.0</td>
</tr>
<tr>
<td>OTHER FOODS</td>
<td></td>
</tr>
<tr>
<td>Haagen-Dazs Coffee Ice Cream/FroYo (8 oz)</td>
<td>58.0</td>
</tr>
<tr>
<td>Haagen-Dazs Coffee Almond Bar (8 oz)</td>
<td>58.0</td>
</tr>
<tr>
<td>Starbucks Coffee Ice Cream (8 oz)</td>
<td>55.0</td>
</tr>
<tr>
<td>Ben and Jerry's Coffee Heath (8 oz)</td>
<td>84.0</td>
</tr>
<tr>
<td>Ben and Jerry's Coffee (8 oz)</td>
<td>68.0</td>
</tr>
<tr>
<td>Jolt Gum (1 stick)</td>
<td>33.0</td>
</tr>
<tr>
<td>Rockstar Gum (1 stick)</td>
<td>80.0</td>
</tr>
<tr>
<td>Naked Energy Smoothie (15.2 oz)</td>
<td>81.7</td>
</tr>
</tbody>
</table>
Part III: Sleep Recall

Please answer honestly and to the best of your ability. Designate your answers as a decimal in the box, rounded to the nearest half-hour.

How many hours of sleep do you get in an average 24-hour period?

Answer the following questions.

Do you take naps?  yes  no

If so, how many on an average day?* (answer as a whole number)

How long is a nap for you, on average? (round to the nearest half-hour, enter as a decimal)

Designate your answers as a time in the box, rounded to the nearest half hour and indicate “AM” or “PM.”

What time do you go to bed on a weekday?

What time do you go to bed on a weekend?

What time do you get up on a weekday?

What time do you get up on a weekend?
REFERENCES
REFERENCES


doi:10.1037/a0026417


Smith, A. (2002). Effects of caffeine on human behavior. *Food and Chemical Toxicology, 40*(9), 1243. doi:10.1016/S0278-6915(02)00096-0


first-year university students in Madrid, Spain. *Journal of American College Health*, 57(2), 150. doi:10.3200/JACH.57.2.150-158


