CAFFEINE USE, HOURS OF SLEEP, AND ACADEMIC PERFORMANCE OF UNDERGRADUATE COLLEGE STUDENTS

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CAFFEINE USE, HOURS OF SLEEP, AND ACADEMIC PERFORMANCE OF UNDERGRADUATE COLLEGE STUDENTS (124 pp)

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The primary objective of this study is to assess the difference in hours of sleep and academic performance between caffeine users and non-caffeine users. Participants were chosen based on current enrollment as a student for the spring 2017 semester at Kent State University. Students included both male and female of any age and any more credits per semester at a Kent State University. Exclusion criteria included students reporting a history of a sleep disorder and participants not currently enrolled at Kent State University. The study consists of a four section anonymous, Qualtrics online survey with a series of questions regarding caffeine consumption, sleep, and academics. The total amount (mg) of caffeine consumed and total sleep duration was determined for each participant. Lastly, participants manually entered in their cumulative GPA. Data was then collected and analyzed using SPSS statistical software using significance $p<0.05$. An univariate ANOVA was used to compare both hours of sleep and GPA to the five levels of caffeine consumption (non-caffeine, low, moderate, high and very high). A t-test was used to compare both the hours of sleep and GPA between caffeine consumers
and non-consumers. A t-test was also used to compare both sex (males and females) and grade level (freshman, sophomore, junior, and seniors) to the amount (mg) of caffeine consumed. Results found that non-consumers have longer sleep duration ($p=0.002$) and higher GPA compared to the consumers group ($p\leq 0.001$), non-caffeine consumers have longer sleep duration compared to the high level of caffeine consumption ($p=0.041$), and that males consume a greater amount (mg) of caffeine than females ($p=0.024$). There were no significant differences ($p>0.05$) between the different levels of intake and GPA and in grade levels and amount (mg) of caffeine consumed.
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CHAPTER I

INTRODUCTION

Insufficient sleep and varying sleep schedules have been widely reported in the college population, with 28% of students reporting daytime sleepiness (Tran et al., 2014) and 25% of students reporting less than six and a half hours per night (Lund et al., 2010; Tsai, 2004). Inadequate sleep can lead to daytime sleepiness and sleep deprivation (Bulboltz, Brown, & Soper, 2001; Gaultney, 2010; Pilcher, Douglass, & Sadowsky, 1997). In the college population, stress can occur due to intrapersonal, environmental, interpersonal, and academic reasons (Ross, Niebling, & Heckert, 1999). Academic and emotional stress, tension and worry are the most common reasons for decreased duration and quality of sleep in college students but also include social situations, cosleeping, and excess noise (Buysse et al., 1988; Ginsberg, 2006; Lund et al., 2010; Pfaford, 2009; Tsai & Li, 2004). To help cope with this sleep loss and be able to fulfill academic duties, students often rely on caffeine (Lazarus, 1993; Lieberman et al., 2015; Thoitis, 1995). Caffeine is used by approximately 92% of college students, 65% using caffeine on a daily basis, with an average of 159 to 849.86 mg caffeine consumed per day (Lieberman et al., 2015; McIlvain, Noland & Bickel, 2011). During times of increased academic stress, 63% of college students have reported an increase in their caffeine intake (Oaten and Cheng, 2005; Tannous & Kalash, 2014).
Sleep is a physical and mental necessity for basic human functioning. For college students, seven to nine hours of sleep per night is recommended; some individuals may need as little as six hours and up to 10-11 hours of sleep per night (Hirshkowitz et al., 2015). Inadequate sleep, less than six hours per night, can lead to acute or chronic sleep deprivation. On average, college students sleep approximately seven hours per night. Twenty-five percentage of students report receiving less than six and a half hours of sleep per night while 29.4% report sleeping at least eight hours. This number varies on the weekends and weekdays, with more sleep being acquired on weekends (Lund et al., 2010). Sleep deprivation is harmful on the health of an individual and can effect the consolidation of memory, alertness and mood, cardiovascular system, immune system, hormone, temperature, and glucose regulation (Colten & Altevogt, 2006; Horne, 1988; Lund et al., 2010; Plaford, 2009).

Caffeine is a central nervous system (CNS) stimulant and mild diuretic found in over 60 species of plants (Heckman et al., 2010; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Katan & Schouten, 2005; Mahan & Escott-Stump, 2008; Parliment, Ho, & Schieberle, 2000; Somogyi, 2010; Merriam Webster; Winston, Hardwick & Jaberi 2005). It works through the competitive binding of adenosine receptors, effecting dopamine, serotonin, and norepinephrine (Basheer, Strecker, Thakker, & Mccarley, 2004; Gupta & Gupta, 1999; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; National Center for Biotechnology Information, n.d.; Winston, Hardwick & Jaberi, 2005). While caffeine can be found naturally or artificially in a number of products, the most common include coffee, tea,
soda, and chocolate (FDA 2010; Heckman et al., 2010; Nawrot et al., 2003; Winston et al., 2005).

Caffeine is not a nutrient and its intake is not required for a healthy diet, but it is generally considered safe in moderate amounts (<400mg/day) (USDA, 2015). Caffeine causes a series of physiological changes, including increased secretion of the stress hormone cortisol (Al'Absi et al., 1998; Lovallo et al., 2006; Randall, 2011). At low to moderate caffeine consumption, perceived benefits include improved cognitive and behavioral effects, enhanced mood, and potentially increased neuroprotection against certain disease (Garrett & Griffiths, 1997; Guerreiro et al., 2008; Gupta & Gupta, 1999; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Parliment, Ho, & Schieberle, 2000; Schardt, 2015; Tieges et al., 2007; Uchida, Kadowaki-Horita, & Kanda, 2014). Higher doses of caffeine can cause various, negative side effects including restlessness, excitement, tremors, dizziness, headaches, and insomnia (UNEP, 2013) and very high doses may cause nausea, vomiting, convulsions, tachycardia, and even death (Gilman, Rall, T.W., Nies, A.S., & Taylor, 1990; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Winston et al., 2005).

The role of sleep has been shown to be very important to perform academically, but the upcoming stress of exams often leads to decreased sleep quality (Abraham & Scaria, 2015; Gaultney, 2010; Zunhammer, Eichhammer, & Busch, 2014). Poor quality and quantity of sleep in college students has a negative impact on the performance of students (Abraham & Scaria, 2015; Becker et al., 2008; Gaultney, 2010). Caffeine’s effect on increasing the stress hormone cortisol and its impact on the sleep cycles may
cause a cycle of inadequate sleep and caffeine consumption and, therefore, long-term sleep deprivation. This cycle may have a substantial effect on the academic achievement of students, since a decrease in quality of sleep has been shown to negatively effect academic performance. Recent studies have shown a negative correlation between energy drink consumption and decreased grade point averages (Champlin, Pasch, & Perry, 2016; Pattison, Rusin, & Bai, 2016; Pettit & DeBarr, 2011). This is further an issue for the large percentage of students reporting decreased sleep as well as increased caffeine consumption during times of academic stress.

**Statement of the Problem**

Caffeine consumption is high in the college-aged population due to the appeal of caffeine’s perceived effects on improved performance, counteracted fatigue, and elevated mood (Gupta & Gupta, 1999; Kristiansen et al., 2005; Parliment, Ho, & Schieberle, 2000; Winston et al., 2005). Caffeine intake has been found to be up to 850 mg/day in college students (McIlvain, Noland & Bickel, 2011) while the recommendation for adults is a moderate intake of <400 mg/day (Mayo Clinic; Johns Hopkins). Caffeine also increases the release of the stress hormone cortisol, which may be problematic for those that use caffeine to cope and the high percentage of students reporting an increase in caffeine consumption during times of academic stress (Al'Absi et al., 1998; Lieberman et al., 2015; Oaten and Cheng, 2005; Tannous & Kalash, 2014). Recent research has even indicated that there is a negative correlation between grade point average and both the
dosage and intake frequency of energy drinks consumed (Champlin, Pasch, & Perry, 2016; Pattison, Rusin, & Bai, 2016; Pettit & Debarr, 2011).

Caffeine has an effect on both the REM and NREM sleep cycle, resulting in decreased sleep quality and/or increased sleep latency (Carrier et al., 2009; James, 1991a; Karacan et al., 1976; Nicholson & Stone, 1980; Smith, 2002). To make up for this lack of sleep, individuals may rely on caffeine the next day to counteract the daytime sleepiness, leading to a cycle of caffeine use and sleep deprivation (Winston, Hardwick, & Jaberi, 2005; Champlin, Pasch, & Perry, 2016; Schardt, 2015). This sleep deprivation is common in college students, with over 48% having short sleep time and 28% reporting daytime fatigue, which poses problems on the mental and physical health (Curcio, Ferrara, & De Gennaro, 2006; Dickelmann and Born, 2010; Lund et. al., 2010; Plaford, 2009; Tsai & Li, 2004). Students with low overall sleep quality tend to have lower GPA’s compared to those who report adequate sleep quality (Curcio, Ferrara, & De Gennaro, 2006; Dewald et. al., 2010; Taylor, et. al., 2011; Orzech, Salafsky, & Hamilton, 2011).

While caffeine may be used to keep a student energized to perform academic duties, its use affects the sleep cycle, causing the quality of sleep to suffer. Sleep quality is essential in the academic setting and when decreased, leads to poorer performance and reduced grade point averages (Abraham & Scaria, 2015; Becker, Adams, Orr, & Quilter, 2008; Gaultney, 2010). While studies have shown an effect of caffeine on sleep and of sleep on academic performance, there is a lack of research assessing the relationship between all three variables. With the high amount of college students consuming caffeine
and reported insufficient sleep, the impact of these on academic performance needs to be further researched.

**Purpose Statement**

The purpose of this study is to assess the difference in hours of sleep and academic performance between caffeine users and non-caffeine users.

**Hypotheses**

$H_1 =$ There is a difference in the hours of sleep between caffeine users versus non-caffeine users

$H_2 =$ There is a difference among the different levels of caffeine consumed and hours of sleep.

$H_3 =$ There is a difference in academic performance between caffeine users versus non-caffeine users

$H_4 =$ There is a difference among the different levels of caffeine consumed and academic performance.

$H_5 =$ There is a difference between the sex and amount of caffeine (mg consumed).

$H_6 =$ There is a difference between grade levels and amount of caffeine (mg consumed).
Operational Definitions

College undergraduate students- full and part-time undergraduate male and female students enrolled and registered for classes for the 2017 spring semester at Kent State University.

Grade Level- The current grade status (freshman, sophomore, junior, or senior) of the Kent State University student.

Level of Caffeine Consumption- The categorized total amount (mg) of caffeine consumed daily.

- Very high caffeine consumer- Intake of > 750 mg of caffeine per day
- High caffeine consumer- Intake of 501-750 mg of caffeine per day
- Moderate caffeine consumer- Intake of 201-500 mg of caffeine per day
- Low caffeine consumer- Intake of 5-200 mg of caffeine per day
- Non-caffeine consumer- The absence of caffeine intake from dietary sources and forms

Hours of sleep- The approximate duration (hours) of sleep per night.

Academic performance- The educational performance demonstrated by the student as assessed by current cumulative grade point average.
CHAPTER II
REVIEW OF LITERATURE

Definition of Caffeine

Caffeine is a 1,3,7-trimethylxanthine, whose chemical structure, C$_8$H$_{10}$N$_4$O$_2$, is similar to the purines (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Oestreich-Janzen, 2016) that can be defined as a “white, bitter crystalline alkaloid compound” that is used medicinally as a stimulant of the central nervous system and also as a diuretic (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Parliment, Ho, & Schieberle, 2000; Somogyi, 2010; Merriam Webster; Winston, Hardwick & Jaberi 2005).

Background Information on Caffeine

Caffeine is the most internationally used psychoactive substance (Fredholm 1995; Heckman, Weil, & Gonzalez, 2010; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Winston et al., 2005). Caffeine is consumed daily by approximately 90% of individuals worldwide, and 80% in the U.S. (Food and Drug Administration [FDA], 2007). In the U.S., approximately 95-98% of caffeine consumed coming from beverages and 1.7-4.2% from foods (Somogyi, 2010). While caffeine is widely known for its “stimulant properties,” it is not clear how this action is preformed (Daly, 1993; Fredholm, Arslan, Johansson, Kull, & Svenningsson, 1997; Garrett &
Griffiths, 1997; Nehlig, Deval, & Debrły 1992). The most commonly accepted mechanism is that caffeine’s similar structure to adenosine allows it to bind to A1 and A2 receptor sites, blocking the binding of adenosine (Basheer, Strecker, Thakker, & McCarley, 2004; Gupta & Gupta, 1999; National Center for Biotechnology Information, n.d.; Nawrot et al., 2003; Winston, Hardwick & Jaberi, 2005). As cited in the U.S. National Library of Medicine (n.d.), caffeine also “competitively inhibits phosphodiesterase, which is the enzyme that degrades cyclic 3’,5’-adenosine monophosphate (AMP).” This competitive blocking causes an “indirect” effect of other neurotransmitters, including ACh, gamma-aminobutyric acid (GABA), dopamine, serotonin, and norepinephrine (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001). Caffeine dilates peripheral blood vessels and stimulates all areas of the central nervous system, including “medullary, vagal, vasomotor, and respiratory centers” especially when taken in higher doses (U.S. National Library of Medicine. (n.d.). This stimulation of the respiratory center can lead to vasoconstriction and an elevated respiratory rate (U.S. National Library of Medicine, n.d.).

**Absorption**

Approximately 90% of caffeine is “removed from the stomach” after twenty minutes of absorption and 99% of caffeine is absorbed within one hour after ingestion from the stomach/intestines, but can also be absorbed directly from the lining of the mouth (Oestreich-Janzen, 2016; Preedy, 2012). The liver processes caffeine and allows absorption into the bloodstream (Preedy, 2012). Once absorbed, the caffeine is circulated
throughout the body’s “fluid and cells,” including the brain, in which it is thought to move freely from blood to the brain, allowing effects on the central nervous system (CNS) (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Lorist & Tops, 2003; Oestreich-Janzen, 2016; Preedy, 2012). Certain caffeine sources are absorbed more quickly, such as chewing gum, gel patches for the skin, and “vapor sticks,” which are similar to e-cigarettes (Oestreich-Janzen, 2016).

**Metabolism**

After absorption, caffeine then binds to plasma proteins, peaking approximately 15-120 minutes after ingestion (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; UNEP Publications, 2003). According to Gropper, Smith, & Groff (2009), caffeine “increases blood flow to the kidneys” and “stimulates” the adipose tissue to release fatty acids.” The liver breaks down caffeine into the following percentage of metabolites- 84% paraxanthine, 12% theobromine, and 4% theophylline (Gonzalez de Mejina & Ramirez-Mares, 2014; Kalow & Tang, 1993; UNEP Publications, 2003). Caffeine is N3-demethylated into paraxanthine through catalyzation of cytochrome P450 (also called CPY), which consists of two subtypes- 1A2 (the primary isoenzyme) and 2E1 (Guerreiro, 2008; U.S. National Library of Medicine, n.d.). Uric acid and uracil derivatives (such as 5-acetylamino-6-formylamino-3-methyluracil, theobromine and paraxanthine) are formed through this demethylation as well as “hydroxylation of the eighth position” (U.S. National Library of Medicine, n.d.; UNEP Publications, 2003). The liver is the organ excreting the caffeine metabolites, with only
2% non-metabolized caffeine being excreted by the kidneys (Preedy, 2012). As cited by Preedy (2012), “caffeine blocks the adenosine receptors, inhibits cAMP phosphodiesterase activity, mobilizes calcium intracellularly, and binds to benzodiazepine receptors.” This chain of events is what makes caffeine is a central nervous system stimulant. CYP1A2 activity differs genetically in each person, which is why caffeine metabolism varies on an individual basis (Butler et al., 1992; Guest, Jamnik, Womack, & El-Sohemy, 2015; Whoriskey, 2015). Also, during pregnancy, caffeine metabolism is decreased, creating higher serum concentrations (UNEP Publications, 2003).

There is a difference of metabolism varies based on sex, age, and smoking (Nawrot et al., 2003). Women typically have 20-30% shorter caffeine half-life than males (Nawrot et al., 2003). During pregnancy, the half-life of caffeine begins at four hours in the first trimester and increases to approximately 18 hours by the third trimester (Nawrot et al., 2003). The half-life of caffeine is two times shorter in smokers (Nawrot et al., 2003). The half-life of caffeine in infants ranges 50 to 100 hours and slowly declines until age 6 months, where the half-life is approximately the same as adults (Nawrot et al., 2003). Until 9 months of age, infants cannot metabolize caffeine very well, resulting in 85% being excreted.

**Excretion**

In the liver, caffeine is broken down via demethylation (Oestreich-Janzen, 2016). Caffeine is oxidized to uric acid, its imidazole ring is cleaved, and then it is further broken down to ammonia where it can then be “exhaled as carbon dioxide” (Oestreich-
Most of the caffeine is excreted in the urine as the metabolite paraxanthine with hardly any of the caffeine excreted intact (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Kalow & Tang, 1993; Oestreicher-Janzen, 2016). More than 95% of caffeine is excreted via urination, with small amounts excreted via bile, saliva, semen, and breast milk (UNEP Publications, 2003). The half-life of caffeine in humans varies in studies from one and a half hours up to nine and a half hours, averaging five hours (Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Lorist & Tops, 2003; Smith, 2002) and two and a half to four and a half hours in another source (UNEP Publications, 2003). Infants and fetuses have less P450 activity than adults, thus allowing them to have a more extended half life compared to adults (Preedy, 2012). A study conducted by Patwardhan, Desmond, Johnson, and Schenker (1980) found that the half-life for 250 mg of caffeine was approximately 6.2 hours for both men and women. Certain factors affect the clearance of caffeine. Oral contraceptives almost double the half-life of caffeine, while the use of nicotine increases the clearance rate by 30-50% (Abernethy & Todd, 1985; Lorist & Tops, 2003; Patwardhan et al., 1980; Preedy, 2012). Alcohol consumption decreases caffeine metabolism as seen in a study by George et al. (1986), where 50 grams of alcohol a day increased the half life by 72% and decreases clearance by 36%. Figure 1 shows the movement of calcium to different parts of the body and the routes to organs.
Figure 1. Caffeine Pathway (Gonzalez de Mejina & Ramirez-Mares, 2014)

Sources of Caffeine

Over 60 species of plants contain caffeine (Somogyi, 2010; Heckman et al., 2010; Katan & Schouten, 2005; Mahan & Escott-Stump, 2008). Cocoa, coffee beans, and tea are the most “commonly cultivated,” while guarana, kola nuts, and yerba mate generally has their caffeine removed and used as additive in commercial products (Frary, Johnson, & Wang, 2005; Heckman et al., 2010; Parliment, Ho, & Schieberle, 2000; Rosenfeld, Mihalov, Carlson, & Mattia, 2014; Somogyi, 2010). Commercial sources with caffeine added often uses caffeine taken from decaffeination process of coffee or with synthetic caffeine, also called anhydrous caffeine (Somogyi, 2010). Commercial beverage sources include soda, energy drinks, energy shots, and caffeinated alcoholic beverages, and
certain snacks such as chips, gum, and mints (Somogyi, 2010). Of the various sources, coffee, tea, chocolate, and soft drinks are consumed most often (FDA 2010; Heckman et al., 2010; Nawrot et al., 2003; Winston et al., 2005). Snacks and baked goods may also contain caffeine if they contain a natural source of caffeine such as foods containing chocolate (Somogyi, 2010). Table 1 lists various caffeine sources and the amount of caffeine (mg) from foods and beverages.

Stimulant drinks, also known as energy drinks, was introduced in 1987 (Finnegan, 2003) and some brands have higher caffeine content than “natural sources” of caffeine (Pettit & DeBarr, 2011; Somogyi, 2010). Roberts (2006) explains that energy drinks typically have around, or maybe a little less, caffeine than soda, but the other ingredients that are added-sugar, herbal stimulants (guarana and ginseng), and taurine- creates a “synergistic effect.” Also, taurine itself increases the effects of caffeine on the body (Roberts, 2006). These stimulant beverages have become more popular, where 26.3 million gallons were sold in 2001 and increased to 354.5 million gallons in 2009 (Beverage World, 2010). While energy drinks can vary significantly in the amount of caffeine, the 2008 Beverage Marketing Corporation, as cited by Somogyi (2010), states that the average content is “50 mg caffeine per 100 ml serving.”

Another source is caffeine powder, which is made of up 100% caffeine and is available to consumers online (FDA, 2015). One teaspoon of caffeine powder is equal to approximately 28 cups of coffee (FDA, 2015). Pharmaceuticals such as diet pills, diuretics, proprietary analgesics, and cold and flu “remedies” may also contain caffeine (Somogyi, 2010; Winston et al., 2005). Some common names for these pharmaceuticals
are Excedrin and NoDoz/Vivarin (Mahan & Escott-Stump, 2008). Table 2 lists various caffeine sources and amount (mg) used in pharmaceuticals, snack foods and supplements. There are other, non-edible caffeine products on the market. ThinkGeek manufactured a soap product that contains caffeine called Shower Shock Caffeinated Soap. The manufacturer claims it contains “12 servings/showers per 4 ounce bar with 200 milligrams of caffeine per serving” (ThinkGeek, n.d.)

Table 1. Caffeine Content of General Food and Beverages.

<table>
<thead>
<tr>
<th>Product</th>
<th>Serving Size</th>
<th>Caffeine (mg)</th>
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<tr>
<td><strong>Coffees</strong></td>
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<td></td>
</tr>
<tr>
<td>Brewed-graved</td>
<td>8 oz.</td>
<td>80-135</td>
</tr>
<tr>
<td>Instant</td>
<td>8 oz.</td>
<td>40-108</td>
</tr>
<tr>
<td>Drip</td>
<td>7 oz.</td>
<td>115-175</td>
</tr>
<tr>
<td>Espresso</td>
<td>2 oz.</td>
<td>100</td>
</tr>
<tr>
<td>Starbucks, regular</td>
<td>16 oz.</td>
<td>259</td>
</tr>
<tr>
<td>Decaffeinated</td>
<td>8 oz.</td>
<td>5-6</td>
</tr>
<tr>
<td><strong>Teas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf teas</td>
<td>7 oz.</td>
<td>50-60</td>
</tr>
<tr>
<td>Instant</td>
<td>7 oz.</td>
<td>30</td>
</tr>
<tr>
<td>Bottles</td>
<td>8 oz.</td>
<td>40-80</td>
</tr>
<tr>
<td><strong>Soft drinks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jolt</td>
<td>12 oz.</td>
<td>71</td>
</tr>
<tr>
<td>Mountain dew</td>
<td>12 oz.</td>
<td>58</td>
</tr>
<tr>
<td>Mellow Yellow</td>
<td>12 oz.</td>
<td>53</td>
</tr>
<tr>
<td>Coca-Cola</td>
<td>12 oz.</td>
<td>45</td>
</tr>
<tr>
<td>Dr. Pepper</td>
<td>12 oz.</td>
<td>41</td>
</tr>
<tr>
<td>Pepsi Cola</td>
<td>12 oz.</td>
<td>37</td>
</tr>
<tr>
<td>RC Cola</td>
<td>12 oz.</td>
<td>36</td>
</tr>
<tr>
<td><strong>Candies &amp; desserts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocolate baking</td>
<td>28 g (10 oz.)</td>
<td>25</td>
</tr>
<tr>
<td>Chocolate chips</td>
<td>43 g (1/4 cup)</td>
<td>15</td>
</tr>
<tr>
<td>Chocolate bar</td>
<td>28 g</td>
<td>15</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------</td>
<td>----</td>
</tr>
<tr>
<td>Jell-O chocolate fudge</td>
<td>86 g</td>
<td>12</td>
</tr>
</tbody>
</table>

Energy drinks

<table>
<thead>
<tr>
<th></th>
<th>Serving Size</th>
<th>Caffeine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red devil</td>
<td>8.4 oz.</td>
<td>42</td>
</tr>
<tr>
<td>Sobe no fear</td>
<td>16 oz.</td>
<td>141</td>
</tr>
<tr>
<td>Red bull</td>
<td>8.3 oz.</td>
<td>67</td>
</tr>
</tbody>
</table>

(Roehrs & Roth, 2008)

Table 2. Caffeine Content of Medications, Snacks, and Supplements.

<table>
<thead>
<tr>
<th>Over-The-Counter Pills</th>
<th>Serving Size</th>
<th>Caffeine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zantrex-3 weight-loss supplement</td>
<td>2 capsules</td>
<td>300</td>
</tr>
<tr>
<td>NoDoz or Vivarin</td>
<td>1 caplet</td>
<td>200</td>
</tr>
<tr>
<td>Excedrin Migraine</td>
<td>2 tablets</td>
<td>130</td>
</tr>
<tr>
<td>Midol Complete</td>
<td>2 caplets</td>
<td>120</td>
</tr>
<tr>
<td>Bayer Back &amp; Body</td>
<td>2 caplets</td>
<td>65</td>
</tr>
<tr>
<td>Anacin</td>
<td>2 tablets</td>
<td>64</td>
</tr>
</tbody>
</table>

Caffeinated Snack Foods

<table>
<thead>
<tr>
<th></th>
<th>Serving Size</th>
<th>Caffeine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crackheads²</td>
<td>1 box, 40g</td>
<td>600</td>
</tr>
<tr>
<td>Crackheads Espresso Bean Candies, regular</td>
<td>1 package, 28 pieces</td>
<td>200</td>
</tr>
<tr>
<td>Wired Waffles</td>
<td>1 waffle</td>
<td>200</td>
</tr>
<tr>
<td>MiO Energy, all flavors</td>
<td>1 squirt, ½ tsp.</td>
<td>60</td>
</tr>
<tr>
<td>Crystal Light Energy</td>
<td>½ packet</td>
<td>60</td>
</tr>
<tr>
<td>Jelly Belly Extreme Sport Beans</td>
<td>1 package, 1 oz.</td>
<td>50</td>
</tr>
<tr>
<td>Jolt Gum</td>
<td>1 piece</td>
<td>45</td>
</tr>
<tr>
<td>Muscle Milk Orange Energy Chews</td>
<td>1.27 oz.</td>
<td>30</td>
</tr>
<tr>
<td>Blue Diamond Almonds, Roasted Coffee Flavored</td>
<td>1 oz.</td>
<td>25</td>
</tr>
<tr>
<td>Perky Jerky</td>
<td>1 package, 1 oz.</td>
<td>10</td>
</tr>
</tbody>
</table>

Supplement

<table>
<thead>
<tr>
<th></th>
<th>Serving Size</th>
<th>Caffeine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSN Hyper Shred</td>
<td>1 capsule</td>
<td>180</td>
</tr>
<tr>
<td>BUZZ EHPLabs</td>
<td>1 scoop</td>
<td>200</td>
</tr>
<tr>
<td>Cellucor C4 Pre-Workout</td>
<td>1 scoop</td>
<td>150</td>
</tr>
<tr>
<td>Product</td>
<td>Quantity</td>
<td>Caffeine Content</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
<td>------------------</td>
</tr>
<tr>
<td>GNC Amp (Pre-Post)</td>
<td>3 tablets</td>
<td>400</td>
</tr>
<tr>
<td>GNC Raw Ravage</td>
<td>1 scoop</td>
<td>200</td>
</tr>
<tr>
<td>Juggernaut HP</td>
<td>1 scoop</td>
<td>150</td>
</tr>
<tr>
<td>Muscle Marinade</td>
<td>1 scoop</td>
<td>300</td>
</tr>
<tr>
<td>Muscle Pharm Assault</td>
<td>1 scoop</td>
<td>300</td>
</tr>
<tr>
<td>MuscleXplosion</td>
<td>1 pouch</td>
<td>60</td>
</tr>
<tr>
<td>Oxyelite Pro</td>
<td>1 capsule</td>
<td>100</td>
</tr>
<tr>
<td>Pre JYM</td>
<td>1 scoop</td>
<td>300</td>
</tr>
<tr>
<td>SportMax Preworkout Shot</td>
<td>1 bottle</td>
<td>140</td>
</tr>
</tbody>
</table>

(Caffeine Informer, 2016; Center for Science in the Public Interest, n.d.)

**Intake of Caffeine Sources in the College Population**

The most popular sources of caffeine in United States colleges are coffee, soda, tea, and chocolate (NACS, 2012; National Association of College Stores, 2012; Tannous & Kalash, 2014; Traylor & Summers, n.d.). Other sources consumed also energy drinks and other food products (Attila & Çakir, 2011). Alcohol mixed with caffeinated beverages is also common in college students (O’Brien, McCoy, Rhodes, Wagoner & Wolfson, 2008; Marczynski, 2011).

**Coffee.** In the college population, coffee is the most commonly consumed source of caffeine, where 41% of college students reported coffee as being the most difficult source of caffeine to give up (Traylor & Summers, n.d.). The percentages of college students daily coffee use is sporadic in the literature, ranging from 57 to 71% for 18-24 year olds (Frary et al., 2005; Mitchell et al., 2003; Traylor and Summers (n.d.). Another study found that 43% of college students reported hot coffee use, 21% “specialty coffee drinks,” 15% iced coffee drink (National Association of College Stores [NACS], 2012).
Zagat’s 2015 Coffee Survey asked American’s what their favorite type of coffee, 24% said a regular cup of coffee, 17% latte, 12% cappuccino, 8% espresso, 8% americano, 5% flavored latte, 5% iced coffee, and 21% said other. A study by Tannous and Kalash (2014) found that 97% of students reported consuming caffeinated products and beverages- 9.7% consumed Nescafé, 12.4% cappuccino, 9.8% coffee, and 3.3% consumed espresso. As to where American’s purchase their coffee, 43% make it at home or get it from work, 26% get it from a large national chain, 22% from a small or independent chain, and 9% reported getting it from “other” (Zagat, 2015). When comparing genders, a seven-day beverage recall of college students found that females consumed more hot coffee (37% female; 32% male) and more specialty coffee drinks (25% female; 16% male) than males (Cozart & Riddle, 2011).

The true caffeine content of coffee can vary greatly depending on the environment the coffee was grown, and roasting, brewing, and grounding method (Roberts, 2006). A study conducted at the University of Florida (2003) periodically sampled the caffeine content of coffees from various shops. When sampling the same Starbucks 16 oz., it was found that the same beverage ranged from 259mg to 564 mg of caffeine. While decaffeinated coffee has the caffeine extracted, not all of the caffeine can be eliminated from the product, thus the end product still contain traces of caffeine. The same Florida study (2003) found up to 18 mg caffeine per 16oz cup of decaf coffee.

**Soda.** According to Schardt (2015), 70% of sodas on the market contain caffeine. Soda is the second most commonly consumed caffeine source in the college population, with a range of 15% (Tannous & Kalash, 2014) to 70% of students reporting
consumption on a daily basis (Frary et al., 2005; Mitchell et al., 2013; Traylor & Summers, n.d.). In a study conducted by Cozart and Riddle (2011), 52% of students reported drinking soda in the past week, with 24% drinking diet soda. The same study also found that females consumed more diet soft drinks (25% female; 20% male) while males consumed more non-diet soft drinks (61% male; 58% female) (Cozart & Riddle, 2011).

**Tea.** The daily caffeinated tea consumption in the college population varies, with sources reporting 12% (Frary et al., 2005), 13.6% (Tannous & Kalash, 2014) up to 54% (Balaghi, Faramarzi, Mahdavi, & Ghaemmaghami, 2011; Mitchell et al., 2013). In a study by National Association of College Stores (2012), 27% college students drank hot tea, 25% drank flavored iced tea, and 14% drank unflavored tea in the previous seven days. Females tend to consume more hot tea per week than males (22% female; 16% male) (Cozart & Riddle, 2011).

**Energy drinks.** Energy drink consumption has been reported as 6.7% (Tannous & Kalash, 2014), 9% (Mitchell et al., 2013), 13-14% (NACS, 2012; Traylor & Summers, n.d) and 48% (Attila & Çakir, 2011). Fifty-one percent of participants in one study reported never using energy drinks (Attila & Çakir, 2011). Caffeine Informer (2016) compiled the most popular energy drinks based on sales. The most popular was Red bull, then Monster, then Rockstar, then Amp and NOS, Full throttle, and lastly Xyience Xenergy (Top Selling Energy, 2016). Another study found that the most popular type of
energy drink in the college population is also Red bull (51.7% preferred) (Attila & Çakir, 2011).

Most studies indicate that males consume more energy drinks in comparison to females (Hidiroglu et al., 2015; Lohsoonthorn et al., 2012; Tannous & Kalash, 2014), where in a seven day beverage recall, 24% of men reported using energy drinks and women only 15% (Cozart & Riddle, 2011). Research suggests that males are 1.5 times more likely to use energy drinks than women (Attila & Çakir, 2011). Females typically consumed more sugar-free varieties of energy drinks (35%) in comparison to men (12%) (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). However, a study by Malinauskas et al. (2007) found that females drank significantly more energy drinks (53%) in comparison to males (42%).

**Alcohol.** Caffeine is often mixed with caffeinated products, such as energy drinks to decrease the flavor of alcohol or not feel/appear drunk, and to become drunk (O’Brien, McCoy, Rhodes, Wagoner & Wolfson, 2008; Marczinski, 2011). When partying, 54% of college students mix alcohol and energy drinks (Malinauskas et al., 2007). One study found that of the 68% of the college students drinking alcohol in the past 30 days, 24% had drank alcohol mixed with an energy drink at least once (O’Brien et al., 2008). Males, Caucasians, fraternity/sorority members, intramural athletes, and underage students were most likely to consume alcohol mixed with energy drinks (O’Brien et al., 2008; Marczinski, 2011). Those that consumed alcohol and energy drink mixtures reported higher alcohol consumption during those drinking occasions (O’Brien et al., 2008). In a study by Berger, Fendrich, and Fuhrmann (2013) found that three out of four students in
the study consumed alcohol mixed with energy drinks in their lifetime, and two of these three consumed this in the past year. However, another study found a lower amount (44%) reported amount of students consuming alcohol mixed with energy drinks in their lifetime, and only 9% reported consuming this in the past two weeks (Marczinski, 2011). Attila & Çakir (2011) found that 37.2% of students reported drinking energy drinks with alcohol and that one third of the current energy drink users first tried energy drinks at a bar.

**Foods.** Other products that contain caffeine include caffeinated gums, chocolate or mocha-flavored products, or products containing coffee or chocolate. This may include ice cream/frozen yogurt (Schardt, 2016), baked goods, puddings, and candy bars. A seven-day recall revealed that 45% of college students consumed cookies/pastries, 38% consumed ice cream/frozen treats, and 32% of students consumed candy bars (NACS, 2012). The caffeinated gum called *Stay Alert Military Caffeine Energy Gum* is often used in the military to keep soldiers awake and more alert during long operations/missions, in which one pack of gum contains five pieces, each containing 100mg of caffeine (Weinberg, 2013). Caffeine in the gum form allows for a much more rapid absorption (five times faster) than caffeinated beverage or foods (Weinberg, 2013).

**Regulations**

There are different regulations between products containing caffeine being labeled as conventional foods versus dietary supplements (Rosenfeld et al., 2014). The difference lies in the “ingredient regulation, labeling, and good manufacturing processes”
(Rosenfeld et al., 2014). In soda, caffeine is considered generally recognized as safe (GRAS) in levels less than 200 parts per million (2% of weight) or 71 mg of caffeine per 12 fluid ounces (Rosenfeld et al., 2014). Any retail food products must list their ingredients by their “common name,” and these must be listed on their product’s packaging when it is greater than or equal to 2% of the ingredients by weight; this includes caffeine Rosenfeld et al., 2014). Caffeine is not required to be on food labels because it is not a “nutrient” but when added to food, caffeine must be listed in the ingredients on food label packaging (FDA, 2016; Roberts, 2006). Dietary supplements, such as energy shots and energy drinks, are not required to list the amount of caffeine (USDA, 2015). However, dietary supplements containing caffeine in “proprietary blends,” the total amount of the blend is the only thing that must be listed (Rosenfeld et al., 2014). The Center for Science in the Public Interest petitioned to the FDA in 1997 to mandate the labeling of caffeine content per serving that is found in caffeine-containing foods and drinks, however the petition is still rendered as “active” and undecided by the FDA (Schardt, 2015).

The combination of alcohol and caffeine is not generally recognized as safe because, when mixed together, the effects of intoxication are lowered (USDA, 2015). In 2010, the FDA issued “warning” statements to four companies, discussing that the added caffeine in their alcoholic, caffeinated malt products were an “unsafe food additive” (FDA, 2010). According to Attila & Çakir (2011), the mixing of energy drinks with alcohol with strenuous physical activity can lead to sudden cardiac death.
Recommendations of Daily Caffeine Intake

Caffeine is not a nutrient and, therefore, not essential in the diet. The current Dietary Guidelines for Americans (2015) state that non-caffeine consumers are “not encouraged” to add caffeine into their regular, daily diet. The recommendation is to limit caffeine to low to moderate intakes. Studies and reports vary in their “classifications” of what is considered “low,” “moderate,” and “high” caffeine doses and intake. Overall, it is stated that single doses of caffeine <200 mg (two cups of coffee or less) is considered non-harmful in adults (European Food Safety Authority, 2015; Mayo Clinic). For pregnant women, it is recommended that caffeine is limited to 200 mg/day (12 oz cup of coffee) since caffeine crosses the placenta (March of Dimes, 2015). Breastfeeding mothers are recommended to limit caffeine to no more than two to three cups/day since small amount of caffeine enter into breast milk (March of Dimes, 2015).

Low intake has been described as <100 mg (Nehlig, Deval, & Debry, 1992), <250mg/day (Winston et al., 2005), and 20-200 mg/day (Garrett & Griffiths, 1997). Low doses of caffeine are thought to cause the benefits of caffeine (Daly & Fredholm, 1998). Caffeine intake between 20 and 200 mg has been noted to increase “well-being, happiness, energy, alertness, and sociability” (Schardt, 2015). Doses up to 2 µg/ml are considered low and stimulate the central nervous system (UNEP Publications, 2003).

Moderate intake has been described as 250-750 mg/day (Winston et al., 2005), 100-200 mg/day (Drug Abuse Warning Network [Dawn], 2011), 200-300 mg/day (Mayo Clinic) and 400 mg/day (USDA, 2015). Five cups of coffee a day (<400 mg) or five soda or tea beverages that contain caffeine (110-345 mg/day) (Gonzalez de Mejia & Ramirez-
Mares, 2014). The general findings are that caffeine can have a positive effect on individuals with the consumption of 200-300 mg/day (Garrett & Griffiths, 1997; Smith, 2002). In the military, soldiers are advised to consume 100-200 mg (considered a moderate dose) of caffeine when tired to increase “alertness and performance” (Schardt, 2015). In some individuals, caffeine intake greater than 200 mg/day can cause negative side effects, such as jitteriness, anxiety, nervousness, and upset gastrointestinal discomfort (Schardt, 2015).

Women that are actively trying to conceive are recommended to limit caffeine use to less than 300 mg/day (Gonzalez de Mejia & Ramirez-Mares, 2014) and breastfeeding mothers are recommended an upper limit of caffeine intake of 200-300 mg (Preedy, 2012). Research has found that >300 mg caffeine/day may result in negatively effect the reproduction of women and the development of the baby (Dlugosz & Bracken, 1992). It has been proposed that 300 mg caffeine/day may lead to a decrease in birth weight (UNEP Publications, 2003). Pregnant women consuming caffeine in moderate doses (less than five to six mg caffeine/kg body weight) is not thought to result in any negative implications on the neonate/fetus Christian and Brent (2001).

High intake has been described as 200-800 (Garrett & Griffiths, 1997), >300 mg (Nehlig et al., 1992), >500 mg/day (Mayo Clinic), and >750 mg/day (Winston et al., 2005). A study by Tieges et al. (2007) found that both “low doses” of caffeine (3 mg/kg bodyweight) and “high doses” (6 mg/kg bodyweight) result in faster response times and reduced errors during an electronic “task switching” activity compared to non-caffeinated participants. Doses exceeding 999 mg caffeine may lead to serious side effects, such as
convulsions, tachycardia, nausea, vomiting, and even death (Gilman, Rall, Nies, & Taylor, 1990; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Winston et al., 2005). UNEP Publications (2003) reports that 10-30 µg/ml can lead to adverse effects, such as restlessness, excitement, tremors, dizziness, headaches, and insomnia, while doses of five gm/ml caffeine is thought to be fatal.

**Current Average Caffeine Intake**

Caffeine intake has increased over the years, where intake has been reported as 165 mg/day in 2013 compared to 120 mg/day in 1999 (Mitchell et al., 2013). Over 95% of adults consume caffeine from various sources, 70-90% of which are from coffee and tea (USDA, 2015). Somogyi (2010) reports that the United States’ caffeine consumption has remained constant, with adults (22 years of age and older) consuming approximately 300 mg/day per person between 2003 and 2008, with 13 to 21 year olds consuming approximately 100 mg/day. Nawrot et al. (2003) report the average, daily caffeine intake in the United States is 3 mg/kg body weight; this would be 205 mg caffeine for a 150 lbs individual. As cited by Somogyi (2010), the National Coffee Association survey found the average of 3.3 cups of coffee/day per capita in 2009, compared to 3.0 cups/day in 2003. As cited by Somogyi (2010), EuroMonitor International reported that as of 2013, the coffee consumption in America was 3.1 kg dry coffee per capita. Only 36% of Americans report they do not consume caffeine (Saad, 2015). There have been differential data on the average consumption of caffeine in the United States, with one study reporting 103.4 mg/day for females and 110.5 mg/day in males 14-21 years old.
A study conducted by McIlvain, Noland & Bickel (2011), found that 65% of the students surveyed reported daily intake of caffeinated beverages and that the average caffeine intake of the participants was 849.86 mg/day (12.08 mg/kg body weight) while another study found that 18-24 year olds had a mean intake of 122mg/day (1.7 mg/kg body weight/day) (Mitchell et al., 2013). Another study had self-reported caffeine intake of participants ranging from 261 mg to 760 mg per day (Tieges, Snel, Kok, Plat, & Ridderinkhof, 2007). Lieberman et al. (2015) found that 92% of college students consumed caffeine, with an average of 159 mg/day for all students surveyed and 173 mg/day for caffeine users. In a study assessing caffeine consumption in 1994-1996 and 1998, 87% of females and 91% of males 18-34 years old consumed caffeine based on “two-day dietary intake data” where the mean intake of caffeine was 166 mg/day for females and 199 mg/day for males; (Frady et al., 2005). This higher caffeine intake in males compared to females has been noted in other studies as well (Lieberman et al., 2015; Pettit & DeBarr, 2011). There is also a pattern of increased caffeine consumption with age (Lieberman et al., 2015; Mitchell, Knight, Hockenberry, Teplansky, & Hartman, 2013; Zagat, 2015), with 28% of college students reporting an increase of caffeine from the previous year (Traylor & Summers, n.d.). Students 21 to 24 years old had a higher percentage of ingesting caffeine more than three times a day, while 17 to 20 year olds consumed the least amount of caffeine (Tannous & Kalash, 2014). A study of college students in Thailand found that females increased their use of stimulants as they aged, but results did not show “a clear pattern” on whether men increased stimulant use with age (Lohsoonthorn et al., 2012). The highest caffeine-consuming age group being 50-59
years old for both males and females with an intake of 295.6 mg and 225.3 mg caffeine per day in 2005-2006 (Somogyi, 2010).

Reasons for Caffeine Use

There are many perceived effects of caffeine that lends its appeal to consumers. These include behavioral and psychological enhancements and providing energy to allow students to study longer, improve attention via feeling more awake, counteract fatigue, and boost mood (Attila & Çakir, 2011; Gupta & Gupta, 1999; Hidiroglu, Tanriover, Unaldi, Sulun, & Karavus, 2013; Usman et al., 2015). Caffeine is also used in social circumstances and because of taste preferences (Attila & Çakir, 2011; Tannous & Kalash, 2014).

Mental energy and performance. Caffeine is consumed for many reasons, often revolving around its perceived effects of “improving cognitive performance, mood, and counteracting fatigue” (Gupta & Gupta, 1999; Kristiansen, Levy-Milne, Barr, & Flint, 2005; Lieberman et al., 2015; Parliment, Ho, & Schieberle, 2000; Snel & Lorist, 2011; Usman, Bhomba, Jawaid, & Zaki, 2015; Winston et al., 2005). Twenty-two percent of students reported that the main reason for their caffeinated beverage consumption was to sense increased alertness (Tannous & Kalash, 2014).

Caffeine is also used when having to make long drives (Attila & Çakir, 2011; Malinauskas et al., 2007). Studies show that caffeine helps to increase alertness on long car drives when the drivers had insufficient sleep (Schardt, 2015). Caffeine is also utilized in the military to help “maintain alertness and performance” in those sleep
deprived (Schardt, 2015). Caffeine is also used as a means to increase performance in sports and athletics (Attila & Çakir, 2011; Usman et al., 2015). As seen in Table 2, many workout supplements contain caffeine. Caffeinated gum or freeze-dried coffee have been used in the military, especially for soldiers who have very long hours of operation (Weinberg, 2013). Gum is used due to the quicker absorption compared to caffeinated beverages or food products. When looking specifically at the use of caffeine in academics, one study found that 17.6% of students used caffeine to endure long, academic work shifts (Tannous & Kalash, 2014) and another study showed that students reported caffeine use for studying and for major projects (Malinauskas et al., 2007).

Looking specifically at energy and stimulant drinks, reasons for consumption are most commonly due to perceived benefits, including improved mental or physical performance (Attila & Çakir, 2011; Hidiroglu, Tanriover, Unaldi, Sulun, & Karavus, 2013; Usman et al., 2015). A study conducted by Malinauskas et al. (2007) found that for both men and women of the study, the top two reasons for consuming energy drinks was due to insufficient energy (68% male; 67% female) and to increase energy (69% male; 62% female).

Mood. Tannous & Kalash, 2014 found that 13.3% of the caffeine consumers indicated that they consumed caffeinated products because it enhanced their mood and 6.6% used caffeine to diminish anxiety (Tannous & Kalash, 2014). The use of energy drinks is also related to the desire to feel more energetic (Attila & Çakir, 2011). Prevention of caffeine withdrawal is another reason but has been proposed that this is
related to the desire to improve the user’s mood (Lieberman et al., 2015; Parliment, Ho, & Schieberle, 2000).

**Sensory appeal.** There is also a sensory aspect that drives the use of caffeinated foods and beverages. These included “curiosity of taste and effects” (Attila & Çakir, 2011; Hidiroglu, Tanriover, Unaldi, Sulun, & Karavus, 2013; Parliment, Ho, & Schieberle, 2000), to replace lost body fluid/thirst (Kristiansen et al., 2005; Lieberman et al., 2015 Usman et al., 2015), and flavor preference (Tannous & Kalash, 2014; Usman, 2015).

**Partying/social contexts.** Caffeine, especially as energy drinks, is commonly consumed in social situations, such as when partying (Attila & Çakir, 2011; Lieberman et al., 2015; Parliment, Ho, & Schieberle, 2000; Usman et al., 2015). Fifty-four percent of the students that consumed energy drinks in one study reported it was with alcohol while partying, and noted that 49% of these users claimed three or more energy drinks were typically consumed during these situations (Malinauskas et al., 2007). Fourteen percent of students reported that a bar was the first place they had ever consumed an energy drink. Those that drink alcohol were also two and a half times more likely to consume energy drinks than non-users (Attila & Çakir, 2011). Students report also using energy drinks to help treat hangovers and as a social pastime (Malinauskas et al., 2007; Tannous & Kalash, 2014).
Benefits of Caffeine Use

The benefits of caffeine consumption are more substantial in individuals that do not consistently consume caffeine (Gropper, Smith, & Groff, 2009; Schardt, 2015).

Cognitive and behavioral effects. According to Kanarek and Lieberman (2011), the cognitive effects of caffeine can be seen more consistently in sleep-deprived individuals, but not than those that are well-rested. Possible behavioral benefits of caffeine include “spontaneous motor activity, learning, and memory” (Borota et al., 2014), and “mental and cognitive performance, vigilance, and endurance” (Gupta & Gupta 1999). This includes producing clearer thoughts more quickly, decreasing fatigue, improving “mental association,” “faster reaction and response times,” and enhanced alertness (Garrett & Griffiths, 1997; Gupta & Gupta, 1999; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Parliment, Ho, & Schieberle, 2000; Schardt, 2015; Tieges et al., 2007). Individual’s personalities may also contribute to the effectiveness of caffeine on human performance. Those that have a lower level of baseline arousal in the morning have shown to have a more significant increase in performance after the administration of caffeine compared to those that have a higher baseline arousal (Gupta & Gupta, 1999). As cited by Snel & Lorist (1998), It has been suggested that caffeine’s benefit in task performance is limited to “simple and moderately complex tasks” in which caffeine used for more complex tasks may worsen performance. There are differential speculations on the benefits of caffeine use, where some
researchers theorize that the seemingly beneficial aspects of caffeine are due to the “relief of caffeine deprivation” for habitual users (Gupta & Gupta, 1999; James, 1994).

**Mood.** Some research indicated an improvement of mood and feelings of well-being in moderate doses of caffeine (Garrett & Griffiths, 1997; Schardt, 2015; Lieberman, Tharion, Shukitt-Hale, Speckman, and Tulley (2002) found that mood was improved in a dose-dependent manner. It has been proposed that this mood improvement may be related to the “anticipated” effects of caffeine or the reversal of withdrawal rather than the actual mechanism of action (Gupta & Gupta, 1999; James & Rogers, 2005; Parliment, Ho, & Schieberle, 2000). Other studies have also found no effect of caffeine on positive mood alterations at 100 and 200 mg dosages (Svensson, Persson, & Sjöberg, 1980; Swift & Tiplady, 1988). However, a study conducted Stern, Chait, and Johanson (1989) found that individuals who ingested a high dose of caffeine reported positive mood change. It is suggested that the lack of findings in the elevation of mood during caffeine administration may be due to the “masking of negative moods” as a result of caffeine withdrawal (Smith, 2002).

**Exercise and athletic performance.** Since it has been shown that caffeine metabolism differs on an individual, genetic basis, caffeine has different effects per athlete (Butler et al., 1992; Guest, Jamnik, Womack, & El-Sohemy, 2015; Whoriskey, 2015). Researchers have found that individuals undergoing training have increased free fatty acids, metabolism, and adrenaline when consuming caffeine at rest in comparison to those not training (LeBlanc, Jobin, Cote, Samson, & Labrie, 1985). The results of short-
term, intense exercise is sporadic in research, with some studies showing no benefit to caffeine use (Perkins & Williams, 1975), while other showing moderate and some significant benefits (Flinn, Gregory, McNaughton, Tristram, & Davies, 1990).

**Neurotransmitters.** Caffeine has an effect on some neurotransmitters, including catecholamines, acetylcholine, serotonin, and amino acids (Gupta & Gupta, 1999). When caffeine and acetylcholine (ACh) precursor choline are “administered together,” short-term memory retention increased in rats by “increasing the “synthesis” of the ACh neurotransmitter (Gupta & Gupta, 1999). Caffeine has a protectant role for neurons and may prevent diseases such as Parkinson’s (Guerreiro et al., 2008; Uchida, Kadowaki-Horita, & Kanda, 2014) and Alzheimer’s disease (Maia & de Mendonca, 2002). This is thought to be caused through the antagonist effect on the adenosine A2A receptor, resulting in an increase of cortical dopamine to increase motor performance and working memory in those with Parkinson’s disease (Uchida, Kadowaki-Horita, & Kanda, 2014). A study by Guerreiro et al., (2008) concluded that the metabolite paraxanthine provides “neuro-protection from cell death of selective nigrostriatal dopaminergic neurons.”

**Negative Effects of Caffeine**

Due to the variability of metabolism, the effects of caffeine differ amongst individuals ((Butler et al., 1992; Guest, Jamnik, Womack, & El-Sohemy, 2015; Whoriskey, 2015). Overall, caffeine may affect the body in many ways, such as causing bone loss (Mahan & Escott-Stump, 2008), delayed conception (Bolúmar, Olsen, Rebagliato, Bisanti, & the European Study Group on Fertility and Subfecundity, 1997;
Nawrot et al., 2003; Stanton & Gray, 1995), mood changes (Gupta & Gupta 1999), and sleep disruptions (James, 1991a).

**Negative cognitive and behavioral side effects.** In general, negative side effects include gastrointestinal distress, aggressiveness, depression, anxiety, irritability, tremulousness/jitteriness, and sleep loss/insomnia (Botella & Parra, 2003; Gupta & Gupta 1999; Journal of the American Medical Association [JAMA], 2001; Schardt. 2015). Caffeine is often consumed by college students as a means to cope with stress, however, studies have shown that caffeine increases the stress hormone cortisol and adrenocorticotropic hormone (which regulates the release of cortisol) (Al'Absi et al., 1998; Lovallo et al., 2006; Randall, 2011) Non-caffeine consumers are generally less stressed compared to caffeine users (Richards & Smith, 2015). A study by Lovallo, Farag, Vincent, Thomas, and Wilson (2006) found that ingesting caffeine periodically during the day resulted in increased cortisol levels throughout the day. The study also highlighted this cortisol increase may be cause by the stimulation of the CNS in males and that in females, “may interact with their peripheral metabolic mechanism” (Lovallo et al., 2006).

**Caffeine withdrawal.** Research suggests that caffeine may cause dependency because of its natural component as a stimulant, therefore, leading to withdrawal symptoms, (Schartd, 2015; Winston et al., 2005). According to Schardt (2015), individuals who began consuming caffeine daily showed distinct “effects on the body” in less than a week. Common symptoms of caffeine withdrawal include headaches, nausea,
vomiting, depression, irritability, inability to sleep, confusion, anxiety, tremors, and fatigue. (Finnegan 2003; McIlvain, Noland, & Bickel, 2011; Nehlig, 2004). Other symptoms listed included fatigue, drowsiness, unable to concentrate (Traylor & Summers, n.d.), gastrointestinal disturbance, nervousness, aggression, hot flashes, heart palpitations, and increased blood pressure (Tannous & Kalash, 2014). In a study performed by Traylor & Summers (n.d.), 40% of college students surveyed had difficulty concentrating with caffeine cessation, 31% of students considered themselves addicted to caffeine, and 31% reported had experiences strong caffeine cravings. It has been proposed that the relief of this caffeine withdrawal causes the perceived benefit of mood improvement (Gupta & Gupta, 1999; James 1994).

Tolerance may occur in individuals that habitually and chronically consume caffeine (Champlin, Pasch, & Perry, 2016) because the “depressant effects” can outweigh caffeine’s “stimulating” component and decrease the brain’s “receptiveness” to caffeine (Gupta & Gupta, 1999; Parliment, Ho, & Schieberle, 2000).

**Caffeinism.** “Caffienism” may occur when high doses of caffeine are consumed. Caffeinism is when high doses, around 1000-1500mg, of caffeine are consumed, leading to “a pharmacological state of acute or chronic toxicity” (Pilette, 1983) and causes a “physical dependence” for caffeine (Smith 2002; Winston et al., 2005). Symptoms include difficulty sleeping/insomnia, agitation, excitement, and “rambling thoughts and speech” (Winston et al., 2005; McIlvain, Noland, & Bickel, 2011). Doses around 10-14 gm caffeine are thought to be fatal (Hodgman, 1998).
**Cardiovascular.** Caffeine also may cause cardiac arrhythmias (Katan & Schouten, 2005), headaches (Hering-Hanit & Gadoth, 2003), and increase homocysteine levels (Katan & Schouten, 2005). High doses of caffeine can result in more serious side effects, including increased heart rate, convulsions, nausea, vomiting, and “increased respiration” (Gilman, Rall, Nies, & Taylor, 1990; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; Winston et al., 2005). A study conducted by Passmore, Kondowe, and Johnston (1987) found that 360 mg of caffeine administered to healthy, male adults resulted in an increased systolic and diastolic pressure, and a late increase in heart rate (three to four hours after administration). The increase in systolic pressure was dose-dependent, while the diastolic was not (Passmore, Kondowe, & Johnston, 1987). Individuals with no tolerance to caffeine may experience temporary spikes in blood pressure, while regular or chronic users do not experience these same elevations in blood pressure or heart rate (Weinberg & Bealer, 2004). However, there is contradicting evidence of caffeine’s correlation of heart attacks and hyperlipidemia (Weinberg & Bealer, 2004) and of caffeine’s effect on heart rhythm or blood pressure in those with a normal blood pressure (UNEP Publications, 2003). As cited by UNEP Publications (2003), there is no link between cardiovascular disease and the consumption of caffeine in moderate doses but findings have indicated that short-term administration (250 mg caffeine) elevated systolic blood pressure.

**Infertility.** Approximately 72% of pregnant women consume caffeine on a regular basis (James, 1991b). High caffeine intake consumed daily has shown to delay conception in women (Bolùmar, Olsen, Rebagliato, Bisanti, & the European Study Group
on Fertility and Subfecundity, 1997; Nawrot et al., 2003; Stanton & Gray, 1995). However, the effect of caffeine on reproduction in research has conflicting results in the delayed of conception or infertility (UNEP Publications, 2003).

**Osteoporosis.** Caffeine is also thought to play a role in the development of osteoporosis, especially in cola beverages (Mahan & Escott-Stump, 2008). Calcium’s absorption by the kidney is decreased after caffeine intake, leading to “increased urinary losses” (Gropper, Smith, & Groff, 2009). It is also thought that caffeine consumption may increase the secretion of calcium in the gut, leading to further calcium loss (Gropper, Smith, & Groff, 2009). Gonzalez de Mejia & Ramirez-Mares (2014) state that “adding two tablespoons of milk to their coffee” may counterbalance the calcium losses from caffeine in those that are at risk of developing osteoporosis.

**Dehydration.** There is differential information on whether or not caffeine leads to dehydration. Generally, studies have found that the diuretic effect is dose dependent, where low to moderate doses of caffeine do not cause acute diuresis, but high doses do (Passmore, Kondowe, & Johnston, 1987). Neuhauser-Berthold, Beine, Verwied, & Luhrmann PM (1997) found that six cups of coffee (642 mg caffeine) caused a negative fluid balance by increasing the 24 hours urine excretion of the participants by 41%. However, these results may not be completely accurate, as the researchers noted that the bioelectrical impedance analysis overestimated the males’ total body water and underestimated the females’ (Neuhauser-Berthold et al., 1997). A diuretic effect was seen in individuals, who do not consume caffeine habitually, when they consumed high
doses of caffeine (250-300 mg) (Maughan & Griffin, 2003). It is thought that consuming caffeine regularly would build up a tolerance to caffeine’s diuretic effect (Caffeine Metabolism, n.d.; Maughan & Griffin, 2003). A meta-analysis found that 300 mg of caffeine caused a minor diuretic effect, with females being more susceptible than males (Zhang et al., 2015). Caffeine consumption is also related to greater sodium excretion and decreased potassium (Passmore, Kondowe, & Johnston, 1987), where one study found sodium excretion was higher in the group consuming coffee compared to the water-drinking group (Killer, Blannin, & Jeukendrug, 2014). Multiple studies have found no evidence to support the previous notions that caffeine has an acute diuretic affect in healthy adults, however, caffeine consumption may affect chronic hydration (Armstrong et al., 2005; Zhang et al., 2015). Caffeine may even contribute to hydration when consumed in a beverage, such as coffee (Killer, Blannin, & Jeukendrug, 2014).

**Prevalence of Caffeine Overdose**

High doses of caffeine may lead to overdose and toxicity, symptoms being restlessness, excitement, sleeping difficulties, frequent urination, and headaches (McIlvain, Noland, & Bickel, 2011). Approximately 83% of college students reported having one or more of these toxicity symptoms, with a mean of nearly three and a half (McIlvain et al., 2011).

Emergency department (ED) hospitalizations have also increased. In 2005, there were 1,128 ED visits related to energy drinks; this number increased, with 16,053 ED visits in 2008 and 13,114 visits in 2009 (Dawn Report, 2011). Sixty-four percent of the
total patients were male, 45% of these visits were individuals aged 18 to 25 years and 32% aged 26 to 39 years (Dawn Report, 2011). Besides energy drink consumption by itself, 52% of individuals aged 18 to 25 were hospitalized for the combination of energy drinks with illicit drugs, alcohol, or pharmaceuticals. From the total data, 16% of the ED visits were related to energy drinks combined with alcohol, with 20% of males and 10% of females receiving the ED visits from this combination (Dawn Report, 2011). The American Association of Poison Control Centers’ annual National Poison Data System (NPDS) report states that in 2013, 1,112 cases involving energy drinks with caffeine coming containing any sources (ie guarana, kola nut, tea, cocoa, etc.), in which 149 were ages 12 to 19 years old and 181 is over twenty years of age (Mowry, Spyker, Cantilena, McMillan, & Ford, 2014). An extreme case of excessive energy drink consumption likely resulted in acute hepatitis in a 50-year-old man whom consumed four to five energy drinks daily for three weeks (Harb, Taylor, Khullar, & Sattari, 2016). His symptoms upon admittance to the hospital were jaundice, upper abdominal pain, nausea, vomiting, malaise, dark urine, yellowing of the sclera (white portion of the eye), and anorexia. While the hospital found he had “evidence of a chronic hepatitis C infection and transaminitis, physicians believe the acute hepatitis was secondary to the high intake of energy drinks (Harb et al., 2016). There were 1,392 “reported events” due to “adverse effects” of dietary supplements containing caffeine between December 31, 2012 and January 1, 2012 (Rosenfeld et al., 2014). There have been two fatalities from the use of caffeine powder reported by the FDA (2015).
**Definition of Sleep**

Carskadon and Dement (2011) define sleep as a “reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment.” Oxford University Press (2016) defines sleep as “a condition of body and mind which typically recurs for several hours every night, in which the nervous system is inactive, the eyes closed, the postural muscles relaxed, and consciousness practically suspended.”

**Sleep Cycles**

Sleep is a cycle of four stages of non-rapid eye movement sleep (NREM) followed by rapid eye movement (REM) sleep (Carskadon & Dement, 2011; Dickelmann & Born, 2010). NREM sleep is a “deeper state of sleep” with “delta waves” and “low levels of autonomic physiological activity” (Colten & Altevogt, 2006). NREM is measured using electroencephalographic (EEG) recordings, which display how each stage of NREM affects the brain’s activity (Colten & Altevogt, 2006). Stage one is the transition from wake to sleep and lasts around one to seven minutes. Stage two is a “slightly deeper sleep” compared to stage one. Stage three is short in the first cycle of sleep and “produces more slow-wave activity” and contains 20% to 50% of the brain’s activity as shown on the EEG. Stage four is has a duration around 20 to 40 minutes, with an activity of 50% or higher. Stages three and four is often referred as “deep sleep”, “delta sleep”, or “slow wave sleep” where an individual needs more “intense stimuli” to wake up in comparison to the previous two stages (Carkadon & Dement, 2011; Colten & Altevogt, 2006).
REM (rapid eye movement) sleep is incorporated into NREM sleep periodically during the normal cycle and shows up as “increased forebrain and midbrain neuronal activity” (Colten & Altevogt, 2006). During REM, dreams occur and the body’s muscles are paralyzed (Colten & Altevogt, 2006; Plaford, 2009). REM sleep is thought that long-term memory storage of experiences and learning occurs (Plaford, 2009). Each cycle of sleep varies, with the first NREM-REM sleep cycle being the shortest, lasting approximately 70-100 minutes, while the following cycles are 90-120 minutes (Carkadon & Dement, 2011). Humans spend approximately 75-80% of their sleep in NREM and around 20-25% in REM (Colten & Altevogt, 2006).

Circadian Preference

The National Sleep Foundation (2015) defines circadian rhythm as “the mechanism that helps govern your sleep and wake time and describes the timing and duration of sleep.” The circadian clock is described as an internal biological clock controlled by the brain that regulates the alertness throughout the day, timing of sleep, wakefulness, as well as other processes (Horne, 1988). Chronotypes for the sleep-wake cycle may be categorized as “morning,” “intermediate,” or “evening” and is generally measured via body temperature, which increases during “wakefulness” and decreases during sleep (Horne, 1988; Horne & Östberg, 1976). Social and behavioral commitments, regulation of sleep, and one’s natural circadian pacemaker are factors that contribute to circadian preference of each individual (Digdon, 2010; Gaultney, 2010).
early adulthood, which includes college students, chronotype preference shift towards most predominately to evening (Taylor, Clay, Bramoweth, Sethi, & Roane, 2011).

Between the three chronotypes, there is a significant difference in the time the individual goes to sleep and the “peak” performance time (Horne & Östberg). On the other hand, the overall duration of sleep was not significant among the three chronotypes, approximately seven and a half for each (Horne & Östberg, 1976). Evening types go to bed approximately 99 minutes later and wake up approximately 120 minutes later in comparison to morning type chronotypes (Horne & Östberg, 1976). The peak time of intermediate and morning have similar “peak times” but intermediate chronotypes go to bed and arise “approximately median” between the morning and evening types (Horne & Östberg, 1976).

Males tend to be more of an evening chronotype compared to females (Digdon, 2010; Lund, Reider, Whiting, & Prichard 2010; Schneider et al., 2014; Tran et al., 2014). Evening types, in comparison to intermediate and morning chronotypes, have a greater chance of developing issues with health, including sleep and psychiatric disturbances, increased daytime sleepiness, and difficulty “adjusting to sleep practices” (Digdon, 2010; Schneider et al., 2011; Taylor et al., 2011; Tran et al., 2014) and more likely to characterize themselves as being “poor sleepers” (Digdon, 2010).

**Function of Sleep**

Sleep is important for psychological and physiological health (Colten & Altevogt, 2006; Lund, 2010 et al.; Plafor, 2009). Sleep is essential for basic functioning,
including alertness, “handling emotions,” and “cognitive performance” (Kilgore, 2010). When an individual is not getting the necessary hours of sleep or has poor quality of sleep, their quality of life is reduced; sleep is a “predictor of illness” for the future (Lund et al., 2010; Buysse, Reynolds, Monk, Berman, & Kupfer, 1988). Sleep strengthens the immune system’s response, thereby increasing the body’s ability to fight infections (Plaford, 2009).

Memory consolidation is when learned information can become “integrated and stored” for long-term memory (Curcio, Ferrara, & De Gennaro, 2006; Dickelmann & Born, 2010). Sleep, mostly during REM sleep, is when this memory consolidation occurs and allows for the storage of learned material and experiences to be stored (Dickelmann & Born, 2010). Therefore, insufficient sleep or poor quality of sleep restricts the ability to consolidate and process memory (Dickelmann & Born, 2010; Plaford, 2009; Walker, 2008), ultimately leading to potential negative impacts on a students’ academic performance (Champlin, Pasch, & Perry, 2016; Gaultney, 2010).

**Current Average Hours and Recommendation of Sleep for College Students**

The amount Americans reporting insufficient sleep, less than six hours per night, has increased by 13% from 2001 to 2001 (National Sleep Foundation: *Sleep in America Poll*, 2009; National Sleep Foundation: *Sleep in America Poll*, 2009). This lack of sleep affects the performance of individuals, making them less likely to “work well and efficiently” (National Sleep Foundation: *Sleep in America Poll*, 2009). The amount of sleep needed may vary between individuals, so there is not a set, “optimal” number of
hours of sleep, however, eight hours of sleep per night has shown to have substantial benefits in regards to memory (Dickelmann & Born, 2010). Appointed sleep experts of the National Sleep Foundation (NSF) created sleep recommendations for each age bracket. These experts recommended that young adults, ages 18 to 25, have seven to nine hours of sleep per night, where 10 to 11 hours per night may be recommended for certain individuals, but sleep should not be less than six hours nor greater than 11 hours per night (Hirshkowitz et al., 2015). According to Lund et al. (2010), college students get approximately 7 hours of sleep per night with 25% of students reporting less than six and a half hours per night and almost 30% getting eight or more hours per night. Sleep schedules were irregular, with 20% of students reporting that in the past month they stayed up all night and 35% reported staying up until three in the morning at least once a week (Lund et al., 2010). Sleep schedules varied by grade level in college students. Freshman and sophomores tended to go to bed and wake up later and juniors and seniors went to bed and woke up earlier (Lund et al., 2010).

**Consequences of Sleep Deprivation**

The college population often experiences “sleep deprivation” and “daytime sleepiness,” (Bulboltz, Brown, & Soper, 2001; Gaultney, 2010) with approximately 28% of students reporting daytime sleepiness (Tran et al., 2014). Sleep deprivation can occur due to either acute situations or cumulative sleep loss (Plaford, 2009). Cumulative sleep loss can occur when an individual is sleeping six to seven hours of sleep or less a night over long periods of time (Plaford, 2009). Females, in comparison to men, are more
susceptible to sleeping difficulties, including a longer amount of time to fall asleep, have higher incidences of disrupted sleep, and report lower quality of sleep (Tsai & Li, 2004; Bulboltz, Brown, & Soper, 2001).

Receiving less than seven hours of sleep per night is one characteristic of “sleep loss” and/or “poor sleep quality” and may lead to the common symptoms of excessive daytime sleepiness, depressed mood, poor memory and poor concentration (Colten & Altevogt, 2006). Memory consolidation occurs during sleep, therefore, the storage of experiences, including learning, is impaired (Plaford, 2009). Cardiovascular, endocrine, immune, and nervous system are affected by sleep loss (Colten & Altevogt, 2006; Horne, 1988; Lund et al., 2010). Negative emotions and increased stress are reported in individuals that have poor sleep quality. These “negative emotions” include anger, confusion, depression, tiredness, and tension (Colten & Altevogt, 2006; Lund et al., 2010; Plaford, 2009).

Sleep deprivation also plays a role in obesity (Colten & Altevogt, 2006; Plaford, 2009). Body temperature decreases with acute sleep deprivation because body temperature regulation is disrupted (Plaford, 2009). To counteract this, the body’s metabolism increases, resulting in increased desire to eat (Plaford, 2009). Also, insufficient sleep affects metabolism and suppresses the body’s ability to regulate blood sugar and, therefore, increases the risk of diabetes (Colten & Altevogt, 2006; Plaford, 2009). The immune system is also affected by sleep deprivation (Colten & Altevogt, 2006; Plaford, 2009). There is a relationship between the reports of “low sleep quality” and “incidences of physical illness” in college students (Lund et al., 2010). The relationship between disrupted circadian clock and immune system leads to the increase
in immune system susceptibility when sleep is disturbed (Plaford, 2009). Chronic inadequate sleep may pose serious, long-term problems. These include in increased risk of sleep disorders, hypertension, heart attack, stroke, and depression (Colten & Altevogt, 2006). Individuals with sleep disorders may have similar consequences of sleep loss, which may also include “excessive daytime sleepiness” and difficulty falling and/or staying asleep (Colten & Altevogt, 2006).

Factors Affecting Sleep

Sleep is affected by numerous variables including stress (Delannoy, Mandai, Honoré, Kobayashi, & Sequeira, 2015), caffeine use (Schardt, 2015), alcohol (Harvard Medical, 2007; National Sleep Foundation, n.d.), smoking (Lohsoonthorn et al., 2012; Wetter & Young, 1994) and other environmental factors.

Stress. Stress and sleep are connected in that lack of sleep can cause stress and stress can cause lack of sleep. According to Wagner, Lorion, and Shipley (1983), school pressures, psychological struggles and identity resolution are main stressors in college students. According to the American Psychological Association (n.d.), 21% of adults report that their stress increases when the length and quality of sleep decreases. Younger generations also are reporting poorer sleep habits compared to older generations; 31% of 18 to 34 year olds compared to 23% of 35 to 40 year olds, 22% of 49-67 year olds, and 14% of 68 years and older (American Psychological Association, n.d.). College students who worry were significantly more likely to report decreased sleep. Wagner et al. (1983) found that stressors that reduce sleep in college students arise from school pressures, the
presence of psychological conflicts, and identity resolution. Having negative emotions during the day has also found to impact the REM stage of sleep and increase activity of the sympathetic nervous system compared to individuals with more positive pre-sleep emotions (Delannoy, Mandai, Honoré, Kobayashi, & Sequeira, 2015).

Caffeine use. Due to caffeine’s effect on the central nervous system and blocking of adenosine, it is often used to provide energy and decrease fatigue (Schardt, 2015). This is beneficial for the users that use caffeine in order to restore energy or “improve performance and alertness” when sleep deprived (Parliment, Ho, & Schieberle, 2000; Schardt, 2015). However, there is a substantial effect of caffeine on sleep. Preedy (2012) states that caffeine “likely has implications for day-to-day performance, behavior, and health” in relation to its affect on sleep. A study by Whittier et al. (2013) found that students who consumed “stimulant beverages” were more 1.37 times more likely to report “excessive daytime sleepiness.” Another study found that students consuming one caffeinated beverage per week were 1.60 times more likely than non-caffeine consumers to report poor quality of sleep (Lohsoonthorn et al., 2012). Students using stimulant drinks had high instances of “daytime dysfunction from sleep” and an increase in the amount of time to fall asleep (Lohsoonthorn et al., 2012). There is a correlation between amount of stimulant beverages and quality of sleep, where the greater amount of stimulant beverages were consumed, the higher incidences of poor sleep quality (Lohsoonthorn et al., 2012). The American Sleep Foundation’s Sleep Study Poll (2009) found that over half of Americans report they are “at least somewhat likely” to use caffeinated beverages during the day to combat sleepiness. The amount of Americans
using caffeine for this purpose has increased by 16% from 2001 to 2009 (National Sleep Foundation: *Sleep in America*, 2001).

Even low concentrations of caffeine can affect the sleep-wake cycle, thereby affecting both the REM and NREM stages of sleep (James, 1991a). Nicholson and Stone (1980) found that hours after the ingestion of 300 mg of caffeine, the “early stages” of NREM and REM sleep were reduced. In the majority of people, sleep can be disturbed if caffeine is consumed three to five hours before bed; they may wake up periodically throughout the night, causing low sleep quality and, therefore, fatigue the next day (Schardt, 2015). Effects of caffeine are dose-dependent, where large doses consumed in the late evening have shown to extend the time it takes to fall asleep at bedtime and decreases the amount of time asleep (Carrier et al., 2009; Karacan et al., 1976; Smith, 2002). To counteract the fatigue from caffeine-induced sleep disturbance, individuals may consume caffeine the next day, thereby creating a vicious cycle (Schardt, 2015). Overtime, this change to the sleep cycle due to long-term caffeine consumption may potentially cause insomnia, leading to chronic sleep deprivation (Winston, Hardwick, & Jaberi, 2005; Champlin, Pasch, & Perry, 2016).

**Alcohol.** Alcohol is consumed for a number of reasons, such as conformity, coping, reinforcement (either positive or negative), or social influences (Kenney, Paves, Grimaldi, & LaBrie, 2014). The National Sleep Foundation (n.d.) reported that 20% of Americans use alcohol to help them fall asleep at night, although alcohol consumed before bed results in a decrease in quality of sleep (Roehrs & Roth, 2001). Researcher’s
believe that perhaps the decrease in the quality, not as necessarily amount, of sleep led to more daytime sleepiness, which in turn, hindered the academic performance of students (Howell, Jahrig, & Powell, 2004; Singleton & Wolfson, 2008). Alcohol decreases REM sleep, disturbs an individual’s circadian rhythm, and decreases restorative sleep via the activation of both delta and alpha activity (Harvard Medical, 2007; National Sleep Foundation, n.d.). 53.8% of college students that drank alcohol in the previous month reported poor sleep quality (average of 8 drinks per week for males and 5 for females) (Kenney, Paves, Grimaldi, & LaBrie, 2014). Students that consumed a “moderate” amount of alcohol (one to 19 drinks per month) had a 39% greater chance of having daytime dysfunction incidences due to sleepiness but were less likely to report short sleep duration (Lohsoonthorn et al., 2012). Students that consumed more than 19 alcoholic beverages per month were three times more likely to report daytime dysfunction due to sleepiness (Lohsoonthorn et al., 2012).

Smoking. Students that smoke cigarettes tend to take longer to fall asleep, have more difficulty completing everyday tasks due to sleepiness, and report overall poor sleep quality compared to those who have never smoked (Lohsoonthorn et al., 2012; Wetter & Young, 1994). While the sleep latency was greater in smokers than non-smokers, smokers were less likely to report short sleep duration (Lohsoonthorn et al., 2012). Since nicotine is a stimulant, it can make falling asleep more difficult for users, especially when using nicotine before bed (Diaz, 2016; Philips & Danner, 1995; Wetter & Young, 1994). Due to the addictive component of nicotine, sleep cycles may be disrupted if the individual experiences withdrawal, which may cause them to wake up throughout the
night (Diaz, 2016; Philips & Danner, 1995; Wetter & Young, 1994). Disordered breathing is also more prevalent in smokers and can decrease the quality of sleep. Another possible reason is any possible psychological troubles” (Wetter & Young, 1994). Cigarette smokers were also more likely to report daytime sleepiness compared to non-smokers (Philips & Danner, 1995)

**Environmental.** An individual’s direct environment can also have a negative impact on sleep. Factors that can prevent or disrupt sleep include “excess noise,” sleeping with others, and social obligations (Lund et al., 2010; Muzet, 2007). Light is also an external factor that influences sleep. Exposure to light late in the night can leading to changes in circadian patterns and can decrease the quality of sleep (Harvard Medical, 2007). The temperature of the room may also impact sleep, in which the “ideal sleep temperature” varies among individuals (Harvard Medical, 2007).

**Definition of Academic Performance**

The terms “academic performance” and “academic achievement” can be used interchangeably. Steinmayr, Meißner, Weidinger, and Wirthwein (2014) state that academic achievement signifies the results of performance, which show the “extent” of an individual’s success towards particular goals to which were the “focus of activities in instructional environments,” specifically in school, college, and university. Academic success can be defined as “a gathering of “personal characteristics” including “mental ability, academic skills, motivation, and goals,” and environmental characteristics (Muuss, 1996). Walberg’s theory of academic achievement is that the “learning
outcome” is dependent on a student’s mental personalities and their “cognitive, behavioral, and attitudinal influences” from their environment (Reynolds & Walberg, 1992).

**Use of Grade Point Average in Assessing Academic Achievement**

Cumulative grade point average (CGPA) is characterized by the grades “A, B, C, D, and F’s,” each corresponding to a given, “numerical measurement” and scaled from 0.00 to 4.00 (Best College Values, n.d.). Grade point average (GPA) is considered traditional and often used when measuring academic in order to assess the student’s ability to “enter” higher education (Karthigeyan & Nirmala, 2012; Steinmayr et al., 2014; York, Gibson, & Rankin, 2015). Feldman & Kubota (2014) state that GPA is an important indicator of success in college and that it may affect a student’s financial aid in the short term and helps to predict career success long-term. According to Masrom and Usat (2015), GPA provides a “greater insight” into the academic performance of students both individually and in “groups.” GPA and grades are thought to be useful by easily assessed for institutions, grades are based off of specific course levels, and also easy to “evaluate programs” within a given “institution” (York, Gibson, & Rankin, 2015). Minimum GPA’s have been set by many institutions to maintain “good academic standing,” where below GPA or grades below that minimum may lead to academic consequences (Olin College, n.d.).

There is a difference in academic performance among genders. In both high school and college, females consistently have a higher mean GPA than males (Astin,
This difference in GPA can be due to different reasons. These include type/difficulty of major (Gallini, 1982; Turner & Bowen, 1999) and skills, in which females also tend to have certain skills, including “organization, self-discipline, attentiveness, dependability, and seeking help from others” (Riegle-Crumb, 2007; Jacob 2002). Jacobs (1999) states that females tend to enroll in colleges that have higher acceptance rates and looser admission rates. However, a study by Ari, Atalay, & Aljamhan (2010) found that the GPA for both males and females had improved exit GPA (compared to entrance GPA), suggesting that there is no gender difference in the improvement of academic performance during college.

**Caffeine and Academic Performance**

There has been an increase in research of the relationship between energy drink consumption and academic performance in the past decade (Champlin, Pasch, & Perry, 2016; Hidiroglu, 2013; Pattison, Rusin & Bai, 2016; Pettit & DeBarr, 2011). Sixty-three percent of students reported their consumption of caffeine increases during time of academic stress (Oaten and Cheng, 2005; Tannous & Kalash, 2014). College students that have a high intake of energy drinks also had higher reports of “perceived stress” than their peers with lower “perceived stress” (Pettit & DeBarr, 2011). In a study conducted by Hidiroglu et al. (2013), students reported their expectations of energy drinks to enhance their mental performance were met. This expectations clashed with findings from other studies, which found that the “frequency” of energy drink consumed was
“inversely related” to the grade point average of first year undergraduate college students (Champlin, Pasch, & Perry, 2016; Pattison, Rusin & Bai, 2016; Pettit & Barr, 2011).

**Sleep and Academic Performance**

As cited by Pettit & Debar, (2011), the American College Health Association states that the most common threats to academic performance are sleep, stress, anxiety, and depression. Academic and emotional stress, tension and worry are also listed as the most common reasons for decreased quality or duration of sleep in college students (Buysse et al., 1988; Ginsberg, 2006; Lund et al., 2010; Plaford, 2009; Tsai & Li, 2004). Poor quality and quantity of sleep in college students negatively impacts performance and grade point average (Abraham & Scaria, 2015; Becker, Adams, Orr, & Quilter, 2008; Gaultney, 2010). Researchers found a positive correlation between sleep times and amount of alcohol consumed, grades were weakly (negatively) associated with sleep duration, suggesting that when the quality, not as much quantity, of sleep is negatively correlated with academic performance via increased daytime sleepiness (Singleton & Wolfson, 2008). Howell et al. (2004) found that while sleep quality is not correlated with GPA, those with lower sleep quality in addition to a full workload performed worse on performance measures. This is shown through the reported reduction in quality of sleep one month before an exam, where 29% of college students reported “poor sleep” during this time (Zunhammer, Eichhammer, & Busch, 2014). Cognitive and behavioral performance in the “academic setting” is negatively affected by the reduction of duration
and quality of sleep by potentially increasing daytime sleepiness (Curcio, Ferrara, & De Gennaro, 2006; Dewald, Meiher, Oort, Kerkhof, & Bogels, 2010).

The body’s immune system requires sleep in order to function properly. Students with inadequate sleep have a greater occurrence of missed class related to physical illness (Lund et al., 2010; Plaford, 2009) and had poorer performance due to “episodes of falling asleep” during class (Lund et al., 2010). Students with the evening chronotype have been reported to have a significantly lower GPA compared to the intermediate and morning types Taylor et al., 2011). This is a problem considering that the total duration of sleep is often reduced in college students due to late school bedtimes (Abraham & Scaria, 2015).
CHAPTER III

METHODOLOGY

Research Design

The study design was a comparative study with five levels of type of caffeine consumer (non-caffeine consumer, low caffeine consumer, moderate caffeine consumer, high caffeine consumer and very high caffeine consumer). When assessing the first hypothesis, the caffeine users and non-caffeine users are the dependent variable and the hours of sleep is the independent variable. When assessing the second hypothesis, the different levels of caffeine consumed is the dependent variables and hours of sleep is the independent variable. When assessing the third hypothesis, GPA is the dependent variable and caffeine users and non-caffeine users are the independent variables. When assessing the fourth hypothesis, GPA is the dependent variable and the dependent variables are the levels of caffeine consumed. When assessing the fifth hypothesis, sex is the independent variable and the amount of caffeine (mg) consumed is the dependent variable. When assessing the sixth hypothesis, grade level is the independent variable and the amount of caffeine (mg) consumed is the dependent variable. For demographic analyses- grade level, sex, and ethnicity were the independent variable while caffeine consumption was the dependent variable.
Research Sample

The email list was provided by the Registrars office and consisted of students who were undergraduates and current Kent State University students as of the spring 2017 semester. This included both male and female of any age and could be either full-time or part-time at a Kent State. During the survey, students were excluded if they were graduate students, students under 18 years of age, or individuals diagnosed with a sleep disorder.

Procedures

The Kent State University Institutional Review Board (IRB) approved the thesis topic, and then the Registrar’s Office gave permission and an email list of 31,585 current Kent State University undergraduate part-time and full time students. The survey was then sent out to students via email through Qualtrics. Upon opening the survey, participants were asked a series of questions regarding their status as a student and sleeping behaviors that may identify them as having a sleep disorder to ensure inclusion criteria. Participants having any exclusion criteria or did not agree to the informed consent was thanked and then dismissed from continuing the survey. The survey was accessible from February 9, 2017 to February 23, 2017. One email reminder was sent out to participants February 16th. To determine caffeine intake, the amounts of caffeine consumed, per Excel spreadsheet uploaded by the participant to Qualtrics, was summed and entered into SPSS software for analysis. To determine hours of sleep, reported fall asleep-wake times were subtracted from one another for both weekend and weekday,
averaged, and entered into SPSS software for analysis.

**Research Measures**

An online Caffeine Consumption, Sleep, and Academic Performance Questionnaire with four sections were used. The questionnaire was developed by Pfaff (2013) and was an updated survey based on the Caffeine Consumption Questionnaire (CCQ) originally created by R. E. Landrum (1992). Updates were made to the caffeine consumption section to incorporate newer sources of caffeine and be shortened to allow students to type in their caffeine beverage if not listed from the shortened list, and can be seen in Appendix B. The survey was available to students through Qualtrics survey creation website online. To begin the survey, students had to agree to the consent form, which can be seen in Appendix C.

Part I had seven questions and consisted of demographic information and questions regarding academic status, number of credit hours per semester, and asked about any history of a sleeping disorder. Part II had three questions and consisted of a caffeine consumption questionnaire, to determine amount of caffeine consumed and how long the participant has been using caffeine. Participants had to download the Excel attachment with a list of various sources of caffeine. From this list, the student must specify- on one typical day- the type of caffeine source consumed, amount of servings of that particular source, and the time it was consumed and then re-upload the Excel document to Qualtrics. This would then allow the sum of the amount of caffeine consumed per day to be calculated. An example was provided on the survey to
demonstrate how to fill out the Excel document using a Brand (other) source for if the source of caffeine they consumed was not on the caffeine source list. Part III had five questions and consisted of a sleep questionnaire to determine the sleep/wake times of students. Part IV had three questions and consisted of an academic questionnaire for participants to record cumulative GPA, which they will type in themselves, the amount of credit hours they are taking, and if they believe their caffeine intake increases during times of academic stress.

**Statistical Analysis**

Data was analyzed using SPSS version 24 statistical software using significance as $p \leq 0.05$. Data includes demographic information, amount of caffeine consumed, hours of sleep, and cumulative GPA. P-value of $p \leq 0.05$ was selected a priori. An univariate ANOVA was used to determine differences between the five levels of caffeine consumption for cumulative GPA and reported hours of sleep. These five levels consisted of non-consumer (<5 mg caffeine), low (5-200 mg caffeine), moderate (201-500 mg caffeine), high (501-750 mg caffeine), and very high (>750 mg caffeine). A t-test was used to assess the difference between the two levels of caffeine consumer (caffeine consumer and non-consumer) between reported hours of sleep and differences between caffeine consumers and non-consumers for cumulative GPA. Post hoc analysis was performed for calculations with significant differences.
CHAPTER IV

JOURNAL ARTICLE

Introduction

Caffeine is not a nutrient and, therefore, its consumption is not required in a healthy diet. However, caffeine consumption is high in the college populations for its perceived benefits in increasing energy and alertness, counteracting fatigue, improving behavioral and cognitive performance, and mood enhancement (Gupta & Gupta, 1999; Kristiansen, Levy-Milne, Barr, & Flint, 2005; Lieberman et al., 2015; Malinauskas et al., 2007; Parliment, Ho, & Schieberle, 2000; Snel & Lorist, 2011; Usman Bhomba, Jawaid, & Zaki, 2015; Winston et al., 2005). Approximately 92% of students consume caffeine and 65% using caffeine daily (Lieberman et al., 2015; McIlvain, Noland & Bickel, 2011). Coffee is the most popular source of caffeine, with soda, tea, and chocolate, energy drinks, and certain medicines also being used regularly. While moderate caffeine intake (<400 mg/day) is generally recognized as safe for the general population (United States Department of Agriculture [USDA], 2015), the average amount of daily caffeine (mg) consumed varying from 159 mg/day to 849.86 mg/day (Lieberman et al., 2015; McIlvain, Noland & Bickel, 2011). Higher doses of caffeine can cause various, negative side effects including restlessness, excitement, tremors, dizziness, headaches, and insomnia (UNEP, 2013) and very high doses may cause nausea, vomiting, convulsions,

Sleep is a physical and mental necessity for basic human functioning. It is recommended that the typical college student receive no less than seven and no more than nine hours of sleep per night (Hirshkowitz et al., 2015). While the average reported sleep duration is seven hours per night, 25% of students report receiving less than six and a half hours, with only 29.4% report sleeping at least eight hours (Lund et al., 2010). Inadequate sleep, less than six hours per night, can lead to acute or chronic sleep deprivation. To make up for this lack of sleep, individuals may rely on caffeine the next day to counteract the daytime sleepiness. However, even in small doses caffeine (100 mg) affects both the rapid eye movement (REM) and non-rapid eye movement (NREM) sleep cycle (James, 2001; Smith, Smith, Miners, McNeil, & Proudfoot, 2000). This sleep disruption results in decreased quality and duration of sleep, causing daytime sleepiness the next day (Carrier et al., 2009; James, 1991a; Karacan et al., 1976; Nicholson & Stone, 1980; Smith, 2002). Therefore, the cycle of sleep loss, daytime fatigue, and caffeine continues, leading to a cycle of caffeine use and sleep deprivation (Winston, Hardwick, & Jaberi, 2005; Champlin, Pasch, & Perry, 2016; Schardt, 2015).

The role of sleep has been shown to be very important to perform academically, but the upcoming stress of exams often leads to decreased sleep quality (Abraham & Scaria, 2015; Gaultney, 2010; Zunhammer, Eichhammer, & Busch, 2014). Poor quality and quantity of sleep in college students have a negative impact on the performance and grade point average of students (Abraham & Scaria, 2015; Becker et al., 2008; Gaultney,
While caffeine may be used to keep a student energized to perform academic duties, its effects have been shown to be less than optimal in certain studies where the increase of energy drinks results in lower grade point averages (GPA’s) (Champlin, Pasch, & Perry, 2016; Pattison, Rusin, & Bai, 2016; Pettit & Debarr, 2011). There is a lack of research assessing the relationship between all the variables—caffeine, sleep, and academic performance. With the high numbers of students reporting insufficient sleep and the excessive amounts (mg) of caffeine consumed, the effect of these variables on the academic performance of students needs to be assessed.

The purpose of this study is to assess the difference in hours of sleep and academic performance between caffeine users and non-caffeine users in undergraduate full and part-time students. It was hypothesized that there will be a difference in GPA and hours of sleep exists between type of caffeine consumer (non-caffeine and caffeine consumer) and between the five levels of caffeine consumption (non-consumer, low, medium, high, and very high). Also, there will be a difference in amount of caffeine (mg) consumed between both sex and grade level (freshman, sophomore, junior, and senior).

**Methodology**

**Research Design**

The study design was a comparative study with five levels of type of caffeine consumer (non-caffeine consumer, low caffeine consumer, moderate caffeine consumer, high caffeine consumer and very high caffeine consumer). When assessing the first
hypothesis, the caffeine users and non-caffeine users are the dependent variable and the hours of sleep is the independent variable. When assessing the second hypothesis, the different levels of caffeine consumed is the dependent variables and hours of sleep is the independent variable. When assessing the third hypothesis, GPA is the dependent variable and caffeine users and non-caffeine users are the independent variables. When assessing the fourth hypothesis, GPA is the dependent variable and the dependent variables are the levels of caffeine consumed. When assessing the fifth hypothesis, sex is the independent variable and the amount of caffeine (mg) consumed is the dependent variable. When assessing the sixth hypothesis, grade level is the independent variable and the amount of caffeine (mg) consumed is the dependent variable. For demographic analyses- grade level, sex, and ethnicity were the independent variable while caffeine consumption was the dependent variable.

**Research Sample**

The email list was provided by the Registrars office and consisted of students who were undergraduates and current Kent State University students as of the spring 2017 semester. This included both male and female of any age and could be either full-time or part-time at a Kent State. During the survey, students were excluded if they were graduate students, students under 18 years of age, or individuals diagnosed with a sleep disorder.
Procedures

The Kent State University Institutional Review Board (IRB) approved the thesis topic, and then the Registrar’s Office gave permission and an email list of 31,585 current Kent State University undergraduate part-time and full time students. The survey was then sent out to students via email through Qualtrics. Upon opening the survey, participants were asked a series of questions regarding their status as a student and sleeping behaviors that may identify them as having a sleep disorder to ensure inclusion criteria. Participants having any exclusion criteria or did not agree to the informed consent was thanked and then dismissed from continuing the survey. The survey was accessible from February 9, 2017 to February 23, 2017. One email reminder was sent out to participants February 16th. To determine caffeine intake, the amounts of caffeine consumed, per Excel spreadsheet uploaded by the participant to Qualtrics, was summed and entered into SPSS software for analysis. To determine hours of sleep, reported fall asleep-wake times were subtracted from one another for both weekend and weekday, averaged, and entered into SPSS software for analysis.

Research Measures

An online Caffeine Consumption, Sleep, and Academic Performance Questionnaire with four sections were used. The questionnaire was developed by Pfaff (2013) and was an updated survey based on the Caffeine Consumption Questionnaire (CCQ) originally created by R. E. Landrum (1992). Updates were made to the caffeine consumption section to incorporate newer sources of caffeine and be shortened to allow
students to type in their caffeine beverage if not listed from the shortened list. The survey was available to students through Qualtrics survey creation website online.

Part I had seven questions and consisted of demographic information and questions regarding academic status, number of credit hours per semester, and asked about any history of a sleeping disorder. Part II had three questions and consisted of a caffeine consumption questionnaire, to determine amount of caffeine consumed and how long the participant has been using caffeine. Participants had to download the Excel attachment with a list of various sources of caffeine. From this list, the student must specify- on one typical day- the type of caffeine source consumed, amount of servings of that particular source, and the time it was consumed and then re-upload the Excel document to Qualtrics. This would then allow the sum of the amount of caffeine consumed per day to be calculated. An example was provided on the survey to demonstrate how to fill out the Excel document using a Brand (other) source for if the source of caffeine they consumed was not on the caffeine source list. Part III had five questions and consisted of a sleep questionnaire to determine the sleep/wake times of students. Part IV had three questions and consisted of an academic questionnaire for participants to record cumulative GPA, which they will type in themselves, the amount of credit hours they are taking, and if they believe their caffeine intake increases during times of academic stress.

**Statistical Analysis**

Data was analyzed using SPSS version 24 statistical software using significance
as \( p \leq 0.05 \). Data includes demographic information, amount of caffeine consumed, hours of sleep, and cumulative GPA. P-value of \( p \leq 0.05 \) was selected a priori. An univariate ANOVA was used to determine differences between the five levels of caffeine consumption for cumulative GPA and reported hours of sleep. These five levels consisted of non-consumer (<5 mg caffeine), low (5-200 mg caffeine), moderate (201-500 mg caffeine), high (501-750 mg caffeine), and very high (>750 mg caffeine). A \( t \)-test was used to assess the difference between the two levels of caffeine consumer (caffeine consumer and non-consumer) between reported hours of sleep and differences between caffeine consumers and non-consumers for cumulative GPA. Post hoc analysis was performed for calculations with significant differences.

**Results**

A convenience sample of 3,246 participated in the survey from the original 31,585 emails sent. From this original sample, 18 participants were removed from study for disagreeing with the consent form. Twenty-four students who reported their age was less than 18 years old were removed from the study. Thirty-one graduate level students were removed from the survey. Two hundred and fifteen participants were removed from the survey for reporting a sleep disorder. Fourteen participants were removed for not being a current, enrolled Kent State University student. This left 2,944 participants that met the inclusion criteria.
Demographic Details of Participants

Of participants, age ranged from 18 to 62 years with the mean age of 21.9 ± 5.8 years (n=2,749). As depicted in Table 3, majority of participants were female (n=2,143, 74.5%), of white or Caucasian ethnicity (n=2528, 87.9%), with the grade level of participants was being highest in freshman (n=773, 27%), followed by seniors (n=760, 26.5%), sophomores (n=684, 23.8%), and lastly juniors (n=651, 22.7%).

Table 3. Frequency and Percentage of Sex (n=2876), Grade Level (n=2868), and Ethnicity (n=2876) of Caffeine Consumers and Non-Consumers of Undergraduate College Students

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>773</td>
<td>27.0</td>
</tr>
<tr>
<td>Female</td>
<td>2143</td>
<td>72.7</td>
</tr>
<tr>
<td><strong>Grade level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>773</td>
<td>27.0</td>
</tr>
<tr>
<td>Sophomore</td>
<td>684</td>
<td>23.8</td>
</tr>
<tr>
<td>Junior</td>
<td>651</td>
<td>22.7</td>
</tr>
<tr>
<td>Senior</td>
<td>760</td>
<td>26.5</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>71</td>
<td>2.5</td>
</tr>
<tr>
<td>Non-Hispanic or Latino</td>
<td>7</td>
<td>0.2</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>8</td>
<td>0.3</td>
</tr>
<tr>
<td>Asian</td>
<td>62</td>
<td>2.2</td>
</tr>
<tr>
<td>Black or African American</td>
<td>126</td>
<td>4.4</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>White or Caucasian</td>
<td>2528</td>
<td>87.9</td>
</tr>
<tr>
<td>Other</td>
<td>71</td>
<td>2.5</td>
</tr>
</tbody>
</table>
**Significant Differences in Sleep Between Caffeine Consumers and Non-consumers**

Differences between hours of sleep between caffeine consumers (n=1340) and non-consumers (n=442) are shown in Figure 2., whereby there was a significant difference in sleep between non-consumers (7.93 ± 1.49) and caffeine consumers (7.66 ± 1.58) \( (p = 0.002) \).

*Figure 2. Significant Difference in Mean Hours of Sleep Between Caffeine Consumers versus Non-Caffeine Consumers*

**Significant Differences in Sleep and Levels of Caffeine Consumption**

There were significant differences between sleep and levels of caffeine consumption. Post Hoc analysis revealed the difference in sleep was significant \( (p = 0.041) \) between non-caffeine consumers (7.93 ± 1.49) and high caffeine consumers (7.42
± 1.40) (Figure 3). There were no other significant differences of hours of sleep among low (7.95 ± 1.43), moderate (7.58 ± 1.50), or very high (7.36 ± 1.74), of caffeine consumption ($p>0.05$): non-caffeine to low consumers ($p<0.001$); non-caffeine to moderate consumers ($p=0.069$); non-caffeine to very high consumers ($p=0.065$); low consumers to moderate consumers ($p=0.200$); low consumers to high consumers ($p=0.087$); low consumers to very high consumers ($p=0.102$); moderate consumers to high consumers ($p=0.922$); moderate consumers to very high consumers ($p=0.871$); or high consumers to very high consumers ($p=0.100$).

*Figure 3.* Mean Hours of Sleep for Each Level of Caffeine Consumption in Undergraduate College Students

**Note:**

Non-consumer: <5 mg (total) caffeine per day
Low consumer: 5-200 mg (total) caffeine per day
Moderate: 201-500 mg (total) caffeine per day
High consumer: 501-750 mg (total) caffeine per day
Very high consumer: >750 mg (total) caffeine per day
Significant Differences in GPA Between Caffeine Consumers and Non-consumers

A t-test analysis revealed a significant difference in GPA between caffeine consumers and non-caffeine consumers (p≤0.001). As depicted in Figure 4, the majority of students were self-reported caffeine consumers (n=1313, 75%), with a mean GPA of 3.30 ± 0.54 compared to 3.46 ± 1.12 GPA of non-consumers.

Figure 4. Significant Differences of Mean Cumulative GPA Between Caffeine Consumers and Non-consumers.

Differences in GPA and Levels of Caffeine Consumption

There were no significant differences between the levels of caffeine consumers on GPA with frequency, percentages, means, and standard deviations as shown in Table 4.

Post Hoc analysis revealed no differences between non-consumers to low consumers (p=1.00); non-consumers to moderate consumers (p =0.807); non-consumers to high
consumers ($p = 0.177$); non-consumers to very high consumers ($p = 0.207$); low consumers to moderate consumers ($p = 0.938$); low consumers to high consumers ($p = 0.360$); low consumers to very high consumers ($p = 0.346$); moderate consumers to high consumers ($p = 0.709$); moderate consumers to very high consumers ($p = 0.653$); or high consumers to very high consumers ($p = 0.999$).

Table 4. Mean GPA and Significance between Levels of Caffeine Consumption in Undergraduate College Students ($n=876$)

<table>
<thead>
<tr>
<th>Consumer</th>
<th>n</th>
<th>%</th>
<th>Mean ± Standard Deviation (points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Consumer</td>
<td>437</td>
<td>49.9</td>
<td>3.46 ± 1.11</td>
</tr>
<tr>
<td>Low</td>
<td>125</td>
<td>14.3</td>
<td>3.45 ± 0.48</td>
</tr>
<tr>
<td>Moderate</td>
<td>180</td>
<td>20.5</td>
<td>3.38 ± 0.45</td>
</tr>
<tr>
<td>High</td>
<td>81</td>
<td>9.2</td>
<td>3.23 ± 0.73</td>
</tr>
<tr>
<td>Very High</td>
<td>51</td>
<td>5.8</td>
<td>3.19 ± 0.53</td>
</tr>
</tbody>
</table>

% = percentage as defined by frequency

**Significant Differences in Sex and Caffeine Consumption**

Table 5 depicts the significant differences ($p < 0.05$) between sexes in the amount of caffeine (mg) consumed. A 2-tailed t-test found that males consume a significantly greater amount of caffeine compared to females ($p = 0.024$).

Table 5. Significant Difference Between Sex and Amount of Caffeine (mg) Consumed ($n=471$)

<table>
<thead>
<tr>
<th>*Sex</th>
<th>n</th>
<th>%</th>
<th>Mean ± Standard Deviation (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>118</td>
<td>25.1</td>
<td>464 ± 447.85</td>
</tr>
<tr>
<td>Female</td>
<td>353</td>
<td>74.9</td>
<td>363 ± 308.77</td>
</tr>
</tbody>
</table>

% = percentage as defined by frequency

*Signifies significant differences ($p=0.024$)
Differences in Grade Levels and Caffeine Consumption

There were no significant differences in the amount of caffeine consumed (mg) amongst any grade level ($p>0.05$) as shown in Table 6. There were no significant differences between freshmen and sophomores ($p=0.994$); freshmen and juniors ($p=0.582$); freshmen and seniors ($p=0.889$); sophomores and juniors ($p=0.374$); sophomores and seniors ($p=0.710$); or juniors and seniors ($p=0.893$).

Table 6. Frequency, Percentage, Mean, and Standard Deviation of Total Caffeine (mg) Consumed in Grade Levels of Undergraduate Students

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>n</th>
<th>%</th>
<th>Mean ± Standard Deviation (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>87</td>
<td>49.9</td>
<td>364 ± 324.27</td>
</tr>
<tr>
<td>Sophomore</td>
<td>104</td>
<td>14.3</td>
<td>351 ± 383.81</td>
</tr>
<tr>
<td>Junior</td>
<td>111</td>
<td>20.5</td>
<td>428 ± 385.73</td>
</tr>
<tr>
<td>Senior</td>
<td>170</td>
<td>5.8</td>
<td>398 ± 336.84</td>
</tr>
<tr>
<td>Total</td>
<td>472</td>
<td></td>
<td>388 ± 350.71</td>
</tr>
</tbody>
</table>

%= percentage as defined by frequency
Discussion

The purpose of this study is to assess the difference in hours of sleep and academic performance between caffeine users and non-caffeine users. The results from the present study indicated: 1) non-caffeine consumers had a significantly higher amounts (hours) of sleep than caffeine consumers, therefore the first hypothesis was accepted; 2) non-caffeine consumers had a significantly higher amount (hours) of sleep than high-intake consumers, but since there were no other significant differences amongst the levels of caffeine consumers, the second hypothesis was only partially met; 3) there was a significant difference in GPA between caffeine consumers and non-consumers; therefore, the third hypothesis was accepted; 4) there was no significant difference between different levels of caffeine consumption on GPA, therefore, the fourth hypothesis was rejected; 5) males consumed significantly higher amounts of caffeine than females; therefore the fifth hypothesis was accepted; 6) there was no difference between the grade levels (freshman, sophomore, juniors, and seniors) and amount of caffeine consumed, therefore the sixth hypothesis was rejected.

Caffeine Consumption

The affect of caffeine consumption on sleep, academic performance, sex, and grade level are not equally significant.

Sleep. The present results of this comparative study between caffeine consumers and non-consumers indicate that non-caffeine consumers have longer sleep duration than caffeine consumers. This generally agrees with previous research where caffeine been
not only been found to decrease the length of sleep time, but also decreases the sleep quality, leading to daytime fatigue (Lohsoonthorn et al., 2012; Whittier et al., 2013). James (1991a) concluded that caffeine, even in small amounts, has been known to affect the sleep cycle, resulting in decreased duration and quality of sleep. This can be related to the present findings, where the sleep cycle of caffeine consumers might be negatively affected by their caffeine intake, resulting in shorter sleep duration than the non-caffeine group.

This concept can also be related to the comparison between the five levels of caffeine consumers, where small quantities of caffeine can affect the sleep cycle, it may be predicted that larger doses would interrupt sleep more substantially. This may then explain the significant difference of sleep duration between non-consumers and high consumers. However, this notion does not reflect the results of present study, which found no difference between non-caffeine consumers and low consumers. Several studies have found that the effects of caffeine are dose-dependent, where large doses consumed in the late evening have shown to extend the time it takes to fall asleep at bedtime and decreases the amount of time asleep (Carrier et al., 2009; Karacan et al., 1976; Smith, 2002). Given that the non-consumer and low consumer have no difference in sleep duration, it is possible that the dose-dependent factor may not start impacting sleep until moderate amounts are consumed, as evidenced by the difference in sleep between moderate consumers and the low and non-consumers. Anxiety is a well-known side effect of caffeine consumption, starting as low as 200 mg doses of caffeine for some individuals (Schardt, 2015). In previous research, anxiety is a common reason for
decreased quality or quantity of sleep (Buysse et al., 1988; Ginsberg, 2006; Lund et al., 2010; Plaford, 2009; Tsai & Li, 2004). This being said, the increase of caffeine consumed may have induced students’ anxiety, resulting in a greater lack of sleep. High caffeine ingestion (10-30 µg/ml or >750 mg caffeine) has been linked to symptoms such as difficulty sleeping and insomnia, which again agrees with the present results of the significant differences between non-consumer vs. consumers and non-consumers and high consumers (McIlvain, Noland, & Bickel, 2011; UNEP Publications, 2003; Winston et al., 2005). The lack of significance between high and very high consumers was not surprising because these two levels have similar negative effects, any of which may hinder academic performance.

According to the American Psychological Association (n.d.), 21% of adults report that their stress increases when their length and quality of sleep decreases. Caffeine is often used to cope with this stress, but since caffeine releases the stress hormone cortisol, stress and worry may be further increased, both of which are factors affecting sleep in the first place (Buysse et al., 1988; Ginsberg, 2006; Lund et al., 2010; Plaford, 2009; Tsai & Li, 2004). Therefore, the use of caffeine may further, negatively impact the duration of sleep among caffeine consumers compared to non-caffeine users as well as cause even more anxiety in the moderate, high, and very high caffeine consumer groups. High caffeine intake also has a slight diuretic effect, in which frequent urination during the night may occur, shortening the amount of sleep for the high and very high consumers (McIlvain, Noland, & Bickel, 2011; Passmore, et al., 1987; Neuhauser-Berthold et al., 1997). This being said, it was surprising that there was not a larger difference between
non-caffeine users and very high (>750mg). This is likely because the effects of caffeine on sleep at the high dose resulted in similar effects as with the very high caffeine doses, even though the amount of caffeine was much higher. It is possible that after a certain level of caffeine is consumed, caffeine’s effect on sleep plateaus, resulting in similar sleep duration.

**Academic performance.** In the present study, GPA of the non-caffeine consumer group was significantly higher than the caffeine consumer group. These findings agree with previous studies that found that GPA is lower in those that consumed caffeinated beverages (energy drinks) (Champlin, Pasch, & Perry, 2016; Pettit & Barr, 2011). Present results show that the non-caffeine consumer and the low-caffeine (5-200 mg) consumer group had similar GPA’s. Based on previous research, an explanation for this could be that low doses of caffeine (20-200 mg) generally reflect benefits, including increased positive moods, energy, alertness, and sociability” (Garrett & Griffiths, 1997; Schardt, 2015; Smith, 2002).

In terms of caffeine versus non-caffeine consumer, it is possible that since the GPA of both the high and very high caffeine intake group was much lower than the non-consumer’s GPA, it was able to bring down the average of the caffeine consumer group enough to have a significant difference between the caffeine consumer and non-consumers. The sleep duration results may also play a role in the significant difference in GPA between non-caffeine users and caffeine users in the present study. Receiving less than seven hours of sleep per night is one characteristic of sleep loss and poor sleep quality and may lead to the common symptoms of excessive daytime sleepiness,
depressed mood, poor memory and poor concentration (Colten & Altevogt, 2006). Also, memory consolidation occurs during sleep, so if the hours of sleep are cut short, the student has less time to store their experiences, including learning, (Plaford, 2009). Since caffeine had a significant impact on sleep between users and non-users and sleep has a widely known effect on academic performance, caffeine may have had an indirect impact on academic performance, explaining why the present results showed non-caffeine consumers had significantly higher GPA’s than caffeine consumers.

When looking at the insignificant differences between the five levels of caffeine consumption and GPA, there are several explanations for each category. Doses up to 300 mg (which falls within the moderate consumer level) have also been found to have these same benefits as low caffeine consumption, however the negative effects of caffeine have also been reported at doses above 200 mg (Garrett & Griffiths, 1997; Schardt, 2015; Smith, 2002). These negative side effects include increased anxiety, jitteriness, insomnia, nervousness, dizziness, headaches, and gastrointestinal distress, nausea, vomiting, and even difficulty concentrating (Gilman, Rall, T.W., Nies, A.S., & Taylor, 1990; Institute of Medicine (U.S.) Committee on Military Nutrition Research, 2001; UNEP Publications, 2003; Winston et al., 2005). The fact that doses in the moderate consumption category may benefit some and negatively impact others may explain why the decrease in GPA of this group was only slightly lower than the non-caffeine and low caffeine consumers groups. A large amount of studies have found that individuals experience negative side effects when caffeine is consumed in high doses (Botella & Parra, 2003; Gupta & Gupta 1999; Journal of the American Medical Association [JAMA], 2001; Schardt. 2015).
This, therefore, gives insight into the results of the present study, where the high and very high caffeine consumer groups had lower GPA’s compared to the non-consumer and low consumer groups (the moderate intake group seemed to be more of a neutral between the lower intakes and higher intakes).

**Sex.** The result of the present study confirms previous research that males tend to consume more caffeine than females (Lieberman et al., 2015; Pettit & DeBarr, 2011). In comparing males vs. females, literature has documented 103.4 mg/day vs. 110.5 mg/day (Somogyi, 2010), 199 mg/day vs. 166 mg/day (Frary et al., 2005) of 295.6 mg/day vs. 225.3 mg/day (Somogyi, 2010). Males do typically weigh more than females, and therefore caffeine consumed per body weight may be a factor in why males consume higher amounts of caffeine (mg). In defense of this argument, males were also found to consume caffeine more frequently, with 91% of males compared to 87% of females consuming caffeine in a two-day dietary intake survey (Frary et al., 2005). While the half-life of caffeine is the same in both males and females, oral contraceptives almost double the half-life of caffeine (Abernethy & Todd, 1985; Lorist & Tops, 2003; Patwardhan et al., 1980). Therefore, if any females were using these medications during the study, their caffeine intake may have been lower due to the prolonged time the caffeine was in their system.

**Grade levels.** For each grade level, there was a large variability in the amount (mg) of caffeine consumed by students. The present study showed no difference in the amount of caffeine consumed (mg) among freshman, sophomore, juniors, and seniors. This does not reflect previous studies that found an increase of caffeine with age and
grade levels. One study states that 28% of college students reporting an increase in caffeine consumption than the previous year (Traylor & Summers, n.d). One justification for this increase is that workloads and difficulty of classes typically increases with grade level, in which caffeine intake has been shown to increase with academic stress (Oaten and Cheng, 2005; Tannous & Kalash, 2014). Therefore, the lack of significant differences between amount of caffeine consumed and grade level may be due to the timing of the survey. The survey was distributed early into the semester, and it may be predicted that the workload was lighter, with lower amounts of academic stress as compared to later in the semester when there are more midterms, projects, and final examinations. Tannous and Kalash (2014) found that 17 to 20 year old students consumed the least amount of caffeine in their study, while students age 21 to 24 years had a significantly higher percentage of caffeine intake. However, caffeine is thought to increase with age and so the small age difference used in the present study may be too short to reflect the long-term increases in caffeine noted in other studies (Frary et al., 2005; Lieberman et al., 2015; Mitchell et al., 2013; Somogyi, 2010; Zagat, 2015). The overall, mean caffeine consumption of the present study was 364mg freshmen, 351mg sophomores, 428mg juniors, and 351mg seniors, with a total average of 374mg caffeine/day. While one previous study had similar results as the current findings, with an average intake of 300 mg caffeine/day, past research generally disagrees with the amount of caffeine consumed daily (Somogyi, 2010). The current findings were higher than some of the other research, which found an average, daily caffeine intake of 165 mg (Mitchell et al., 2013), 173 mg (Lieberman et al., 2015), and 183 mg (Frary et al., 2005).
The current study did have a lower mean caffeine intake than one study, which reported the average daily intake to be 850 mg caffeine (McIlvain et al., 2011).

**Applications**

Stress, inadequate sleep and caffeine use are common in the college population. As seen in the present study, the use of caffeine has negative effects on both the grade points average and sleep duration of students. A high percentage of participants reported consuming caffeine, and many were consuming caffeine doses above the recommended limit, thus making it important to address the issues and negative effects of caffeine. Therefore, education on time management, sleep hygiene, and healthy consumption is critical in maintaining the health of this population. Sleep deprivation is linked to both acute and chronic problems. Overall, the effect of inadequate sleep may directly impact the ability of the student to learn and perform efficiently in the academic setting. Long-term consequences of sleep loss is related to obesity, reduced immune system function, and cardiovascular issues. Thus, educating students on the importance of sleep hygiene will help the students reach their academic potential and decrease the risk of developing future health problems due to chronic sleep deprivation.

A greater emphasis on the importance of moderation of caffeine use can help decrease the negative side effects of high caffeine consumption. Not only is high caffeine consumption linked to infertility, osteoporosis, and possible cardiovascular problems, but also the contents of commonly consumed caffeine sources may contribute to future health problems. Many regularly consumed sources contain high amounts of
sugar and fat, such as flavored coffees, sweetened teas, soda, and chocolates. With the high frequency of these products being consumed daily, consumers must be more aware of the negative impacts of these added calories and its contribution to obesity.

Stress is a common encounter for not only college students, but also working adults. The juggling of deadlines, exams, and personal responsibilities can result in decreased sleep quality and duration. The cycle of inadequate sleep and the use of caffeine to cope with the stress are unhealthy and continue to be a problem in society. By teaching time management skills, emphasizing the importance of sleep, and more effective ways to cope with stress, the cycle of sleep deprivation and caffeine use may be relieved.

Integration of time management, sleep hygiene, and moderation of caffeine intake should begin at the freshman level, where students may experience substantial changes in these three subjects when transitioning from home to a college campus. By incorporating a stress management component to freshman orientation, each of these topics can be addressed along with their implications on overall health and academic performance. In addition, dorm hall visits or on-campus seminars for all grade levels held by a knowledgeable party may be considered for interested students to attend and receive information on these topics. This would allow for a smaller group size, where students have a greater opportunity to ask questions and have greater interaction amongst their peers. Many universities are already implementing health education programs. Ball State University has a health, alcohol, and drug education program that has trained peer health educators go to sororities, fraternities, and dorms to present health information. These health topics may include healthy eating, caffeine, stress management, sleep
hygiene, and more. Other colleges also have similar programs that can be presented per request. A few examples of these schools include Indiana University-Purdue University Indianapolis, Davidson College, and University of Missouri-Kansas City. The University of New Hampshire has a stress management program that offers many different workshops, including meditation, poetry/expressive writing, color therapy, and more. Berkeley University also offers workshops for health education with topics including alcohol education and stress and resilience. Even with these programs already being in place, the incidences of reported high caffeine intake, stress, and lack of sleep demonstrates the need to reassess and improve college and university’s current programs.

**Limitations**

The demographic information was not distributed equally, with greater amounts of females (75%) and white/Caucasian ethnicity participating in the survey. Participants in the study were generally of good academic standing. A larger demographic area could allow more insight on the effects of caffeine and sleep on academic performance in diverse populations with a more variable GPA range.

The participants’ current state of academic stress was not addressed in the survey, which may affect the have affected reported caffeine intake, such as if one student had an upcoming exam and their caffeine intake was higher than their usual. Future studies would benefit from reporting caffeine consumption across an entire semester to better assess caffeine intake patterns as academic stress changes. Also, understanding and assessing other types of stress, besides academic, that students undergo may provide
more insight that can be related to sleep disturbances, caffeine intake, and its affect on
academic performance.

The survey used in the present research collected duration of sleep only when looking at academic performance. Research has shows that the quality of sleep has a greater impact on academic performance than just the duration. Similar studies in the future may consider incorporating questions to assess the quality of the participant’s sleep per night.

Another limitation of the present study is that the true amount of caffeine consumption (mg) was difficult to determine. A set number was used for certain sources of caffeine (i.e. brewed, cold brewed, percolated, etc.) when a specific brand was not named. The true level of caffeine in those sources may vary considerably depending on brewing method, number of coffee beans/scoops used, and the brand used. Having more specific documentation on the sources of caffeine in future studies can help researchers obtain a more accurate, total amount of caffeine consumed.

Conclusion

This research study confirmed that in undergraduate students, those consuming caffeine received significantly less hours of sleep per night compared to students reporting no caffeine intake, especially between non-caffeine consumers versus those consuming high levels of caffeine (500-570 mg caffeine/day). The GPA of non-caffeine consumers was significantly higher than that of caffeine consumers. These results pose a problem with current college practices in regards to caffeine use and insufficient sleep. Since caffeine is often used by college students in the academic setting, education is
needed not on just the negative side effects of caffeine use, but its impact on sleep and therefore, academic performance.
APPENDICES
APPENDIX A

SURVEY EMAILS
Appendix A

Survey Emails

Original Email for Survey Link

Dear Student,

My name is Danielle Gabrish and I am conducting research on the difference between caffeine use, sleep, and academic performance in undergraduate college students. The survey is web-based and answers are strictly anonymous. The survey will take approximately 5-7 minutes. Participation is voluntary and refusal to take part in the study involves no penalty. Participants may withdraw from the study at any time without penalty. Your time and participation is much appreciated.

Sincerely,
Danielle Gabrish

Follow this link to the Survey:
Take the survey

Or copy and paste the URL below into your internet browser:
https://kent.qualtrics.com/SE/?Q_DL=0xk0crZXWrNGh7L_6RnNwFutsUqqQmh_MLRP_eKlf0b2srJWbvT&Q_CHL=email
Reminder Email for Survey Link

Dear Student,

My name is Danielle Gabrish and I am conducting research on the difference between caffeine use, sleep, and academic performance in undergraduate college students. If you have already completed this survey, I thank you for your participation and you may disregard this email. The survey is web-based and answers are strictly anonymous. The survey will take approximately 5-7 minutes. Participation is voluntary and refusal to take part in the study involves no penalty. Participants may withdraw from the study at any time without penalty. Your time and participation is much appreciated.

Sincerely,
Danielle Gabrish

Follow this link to the Survey:
Take the survey

Or copy and paste the URL below into your internet browser:
https://kent.qualtrics.com/SE?Q_DL=9yjXOhX7Q5Gz1JP_6RnNwFutsUqqQmh_MLRP_9NxXYYqyML2BvZH&Q_CHL=email
APPENDIX B

SURVEY QUESTIONNAIRE
Appendix B
Survey Questionnaire

Caffeine use, sleep, and academic performance in undergraduate college students

Q19 Informed consent
☐ I agree (1)
☐ I disagree (2)
Condition: I disagree Is Selected. Skip To: End of Survey.

Part I: Demographic Information

Q1 Age ___

Q2 Sex
☐ Male (1)
☐ Female (2)

Q3 Ethnicity
☐ Hispanic or Latino (1)
☐ Non-Hispanic or Latino (2)
☐ American Indian or Alaska Native (3)
☐ Asian (4)
☐ Black or African American (5)
☐ Native Hawaiian or Other Pacific Islander (6)
☐ White or Caucasian (7)
☐ Other (8) ____________________

Q4 Are you currently a student enrolled at a Kent State University?
☐ Yes (1)
☐ No (2)
If No Is Selected, Then Skip To End of Survey

Q18 What is your grade level?
☐ Freshman (1)
☐ Sophomore (2)
☐ Junior (3)
☐ Senior (4)
☐ Graduate (5)
If Graduate Is Selected, Then Skip To End of Survey
Q5 How many credit hours are you taking this semester? ___

Q6 Have you ever been diagnosed with a sleeping disorder?
☑️ Yes (1)
☑️ No (2)
If Yes Is Selected, Then Skip To End of Survey

**Part II: Caffeine Consumption Questionnaire**

Q8 Do you consume caffeine?
☑️ Yes (1)
☑️ No (2)
If No Is Selected, Then Skip To End of Block

Q9 at what age did you start consuming caffeinated beverages/diet pills (excludes chocolate products)? ___

Q11 Please open the attachment "Caffeine Source List" below and type in the number of servings of the caffeinated product and the time(s) when they are typically consumed in one average day. If the beverage/product is not listed, please type in the specific name along with the quantity and time consumed. Re-upload once form is complete. Caffeine Source List

<table>
<thead>
<tr>
<th>Serving size</th>
<th>Caffeine Source</th>
<th>Servings Consumed</th>
<th>Time(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 oz. (small)</td>
<td>Coffee</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regular brewed, drip (Maxwell, Folgers, Eight O' Clock)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regular, instant (crystallized coffee that dissolves in hot water)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cold-brew coffee</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decaffeinated, brewed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decaffeinated, instant</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 oz.</td>
<td>Espresso shot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 K-cup (8 fl oz.)</td>
<td>K-cup coffee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 K-cup (8 fl oz.)</td>
<td>K-cup coffee extra bold</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Brand (other):**

<table>
<thead>
<tr>
<th>1 tea bag (1 tsp of loose tea)</th>
<th><strong>Tea</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black/Earl grey tea</td>
</tr>
<tr>
<td></td>
<td>Green tea</td>
</tr>
<tr>
<td></td>
<td>Chai tea</td>
</tr>
<tr>
<td></td>
<td>Instant tea</td>
</tr>
<tr>
<td></td>
<td>White tea</td>
</tr>
<tr>
<td>1 can (23 oz.)</td>
<td>Arizona iced green tea</td>
</tr>
<tr>
<td>1 can (12 fl oz.)</td>
<td>Lipton Brisk iced tea</td>
</tr>
<tr>
<td>1 K-cup (8 fl oz.)</td>
<td>K-Cup tea</td>
</tr>
</tbody>
</table>

**Brand (other):**

**Cocoa and chocolate**

<table>
<thead>
<tr>
<th>1 cup (8 fl oz.)</th>
<th>Hot chocolate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bar (1.5 oz.)</td>
<td>Hershey’s milk chocolate bar</td>
</tr>
<tr>
<td>1 piece</td>
<td>Hershey's milk chocolate kiss</td>
</tr>
<tr>
<td>1 piece</td>
<td>Hershey's dark chocolate kiss</td>
</tr>
<tr>
<td>1 packaged cup</td>
<td>Chocolate pudding</td>
</tr>
<tr>
<td>1 cookie</td>
<td>Chocolate chip cookie</td>
</tr>
<tr>
<td>1/2 cup</td>
<td>Chocolate ice cream</td>
</tr>
<tr>
<td>1/2 cup</td>
<td>Mocha Ice cream</td>
</tr>
<tr>
<td>1 cup (8 fl oz.)</td>
<td>2% Chocolate milk</td>
</tr>
<tr>
<td>1 cup (8 fl oz.)</td>
<td>Silk Chocolate soymilk</td>
</tr>
</tbody>
</table>

**Brand (other):**

**Soft Drink**

<table>
<thead>
<tr>
<th>1 can (12 fl oz.)</th>
<th>Coca-Cola</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dr. Pepper</td>
</tr>
<tr>
<td></td>
<td>Mountain Dew</td>
</tr>
<tr>
<td></td>
<td>Mr. Pibb</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td>Pepsi Cola</td>
</tr>
<tr>
<td></td>
<td>RC Cola</td>
</tr>
<tr>
<td></td>
<td>Mello Yello</td>
</tr>
<tr>
<td></td>
<td>Root Beer</td>
</tr>
<tr>
<td></td>
<td>Brand (other):</td>
</tr>
</tbody>
</table>

**Energy Drinks**

<table>
<thead>
<tr>
<th></th>
<th>8.4 fl oz.</th>
<th>Red Bull</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Monster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Rockstar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>NOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Amp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Full Throttle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (8 fl oz.)</td>
<td>V8 C-Fusion + Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (8 fl oz.)</td>
<td>Mountain Dew Kick Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Venom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 can (16 fl oz.)</td>
<td>Xyience Xenergy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 container (6 fl oz.)</td>
<td>5 hour energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brand (other):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Over-The-Counter Pills**

<table>
<thead>
<tr>
<th></th>
<th>2 capsules</th>
<th>Zantrex weight loss supplement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 capsule</td>
<td>Noz Doz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 capsule</td>
<td>Vivarin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 tablets</td>
<td>Excedrin migraine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 capsules</td>
<td>Midol complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 capsules</td>
<td>Bayer back and body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 tablets</td>
<td>Anacin</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brand (other):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Supplements**

<table>
<thead>
<tr>
<th></th>
<th>1 scoop</th>
<th>BPI 1.M.R.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 capsule</td>
<td>BSN Hyper Shred</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 scoop</td>
<td>Cellucor C4 or C5 Extreme</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 scoop</td>
<td>Cellucor C4 Pre-workout/mass/ripped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 scoop</td>
<td>Muscle Pharm Assault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 scoop</td>
<td>MuscleTech Neurocore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 scoop</td>
<td>Pre JYM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16 teaspoon</td>
<td>Pure caffeine powder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B-complex supplement brand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brand (other):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Part III: Sleep Questionnaire**

Q13 What time do you typically fall asleep on weekdays? _____

Q14 What time do you typically wake up on weekdays? _____

Q15 What time do you typically fall asleep on weekends? _____

Q16 What time do you typically wake up on weekends? _____

Q17 How long does it take you to fall asleep once you've laid down? _____

Q18 What is your cumulative grade point average (GPA)? _____

Q19 How many of your credit hours are online? _____

Q20 Do you feel your caffeine intake increases during times of academic stress (i.e. upcoming exams)?

- Yes (1)
- No (2)
APPENDIX C

CONSENT FORM
Appendix C

Consent Form

Differences Between Caffeine Use, Hours of Sleep, and Academic Performance of Undergraduate College Students

“Difference between caffeine use, hours of sleep, and academic performance” is a web-based survey to analyze the differences between. 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 willingly consent to participate in the study.

Consent Form

The study involves a web-based experiment designed to help identify the effects of caffeine on sleep and academic performance. The study is being conducted by Danielle Gabrish of Kent State University, 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).

This survey will take approximately 5-7 minutes and answers are strictly anonymous. The study consists of four sections. Participants begin by answering demographic and exclusion criteria questions. After, the participants will answer a series of caffeine consumption questions, including filling out a table on their typical intake of listed caffeine sources. Participants will then answer a sleep questionnaire to assess sleep and wake times. Lastly, participants will answer academic questions, in which their cumulative grade point average will be entered.

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).

Individuals' participation in this study does not include any compensation (i.e. monetary or class credit). The study is restricted to a specific population and will not be assessable to visitors of this website. Participation is voluntary; refusal to take part in the study involves no penalty. Participants may withdraw from the study at any time without penalty.

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact the principal investigator, Associate
Professor Natalie Caine-Bish, at (330)-672-2197; or the Kent State University Institutional Review Board, at (330) 672-0709.

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 experiment.
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