

**The Effects of Sleep Deprivation and the Consumption
of Caffeine on High School Students' Academic
Performance in Surabaya, Indonesia**

AP Research

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INTRODUCTION

Sleep deprivation, commonly defined as sleeping less than the recommended eight or nine hours, is increasingly receiving attention as accumulating adolescents from aged 12-19 experience sleep loss (Loessl et. al., 2008). From then until now, those who have valued their work over their sleep, as they make up for their sleep loss from their weekdays to their weekends (Loessl et. al., 2008), have been affected by people's cognitive functions. In particular, standards for academic background have risen, resulting in the inevitable academic pressure upon students, especially high school and college students, who are working their way up to universities and colleges or jobs and internships. For example, Shur-Ken Gau and Wei-Tshen Soong (1995), who strived to investigate the cause and effect of the increasingly sleep deprived high school students in Taipei, reports that students in higher grade levels have increasingly less sleep because of the joint entrance examination (JEE) they have to pass to get into college. Although people under 15 may be sleep deprived, because sleep decreases with increasing age (Loessel, 2008), this paper will focus on the data of high schoolers that are above age of 15.

To endure the pressure to sleep, adolescents generally consume caffeine for cognitive enhancement when finishing tasks. Because caffeine is a legal stimulant that is accessible to adolescents, the average intake of caffeine was " 3.2 ± 2.0 mg/kg/day," which is more than research prior to this paper found (Bernstein et al., 2002, p. 3). Due to the accumulation of caffeine consumption, adolescents may undergo various effects that could potentially hinder their studies. Research on adults reveals that long term effects may prove to be harmful for the cognitive function, even if it may be satisfactory for a short period of time for the cognitive state (Nehlig, 2010). By connecting and comparing research conducted in the past supplies further understanding of the effects of sleep deprivation in relation to the consumption of caffeine, perhaps providing a general correlation between the former and the latter on adolescents and their studies; however, despite the countless studies that seem to have been gaining interest in the sleep deprivation of high school students, nearly no studies have went on to measure the effects of caffeine consumption on high school students after sleep deprivation, typically on analyzing the direct measure on their studies. Examining the effects on high school students is imperative as biological processes come into play. The fact that the majority of research focuses on adults arises the need to identify the effects on the less commonly studied group from which the question driving this study appear: How does sleep deprivation and the consumption of caffeine

affect high schools students, typically in the age of 15 to 19, on their academic performance in Surabaya, Indonesia?

LITERATURE REVIEW

Before the discourse on the specific effects that affect high school students' studies, it is vital to examine the general impact of sleep deprivation and the consumption of caffeine yield. Even though the academic performance of high school students can be affected in many ways, as sleep deprivation and the chronic consumption may affect an individual's health and generate extreme, unfavorable thoughts ultimately hindering his/her learning (Meldrum & Restivo, 2014), those variables are beyond of the scope of this paper, which will focus on the more direct perspective, the cognitive function. It is also essential to analyze multiple sources regarding those effects as although the consensus is the decline in cognitive functions, the specific results differ from each study as the measure, type, and length of the motor task may affect the result (Pilcher & Huffcutt, 1996, p. 319). In regards to their cognitive performance, three significant and most studied aspects to investigate are working performance, memory, and mood.

In general, researchers Xue Ming et. al. (2011) at the Department of Neurosciences and Neurology, sought to understand the effects of sleep deprivation on high school students, whom only 33.7% surveyed had adequate sleep on the weekdays. The results showed that the lack of sleep leads to a superimposed circadian disadvantage, which intensifies the ability of high schoolers to fall back into their normal sleep cycle, ultimately hindering their academic performance as their school grades went down (Ming et. al., 2011). Similarly, research conducted in Taipei supported that claim by reporting that the JEE high school students studying for long hours showed a negative correlation between sleep and performance. In conclusion from the two studies, it is in concordance that students elicited an increase in complaints and sleepiness during daytime and showed a decrease in academic performance (Gau & Soong, 1995; Ming et. al., 2011). Following the effects of sleep deprivation, highlighting the general effects of consumption of caffeine after sleep deprivation on their studies is essential; however, there are no studies found that suggest those direct analysis, so looking at three factors would be necessary in order to deduce and imply to answer the research question.

Working Performance

Working performance refers to the extent to which one can perform cognitive tasks; the variables that require to measure working performance are primarily alertness and vigilant attention. Alertness and attention remain stable when on normal waking days, or in sufficient sleep; however, when it hits 16 hours of sleep loss, there seems to show “a substantial slowing of reaction time (RT) and worsening of performance accuracy on tests of psychomotor vigilance” (Killgore, 2010, p. 106). Furthermore, psychomotor vigilance decreases as the length of a task increases, also known as the ‘time-on-task effect,’ which is exacerbated by sleep deprivation (Killgore, 2010, p. 107). Yet, that is not to say that the sleep deprived individuals apply no effort. In a study conducted by researchers Pilcher and Walters (2010), sleep deprived individuals were reported to have expended more effort than the non-deprived participants even if their performance was worse. This report not only justifies the worsening of alertness and vigilant attention but also provides a further understanding of why this topic should be studied as students are forbidding sleep because they believe they are making progress when empirical results show otherwise.

Because of such drawbacks, adolescents generally consume caffeine to improve their cognitive functioning; however, the short-term and long-term effects reveal contrasting results. The short-term effects primarily concern the alleviation of the detriments on alertness and attentiveness when sleep deprived. Attention and alertness are alleviated in low doses of caffeine when anxiety is reduced and concentration is improved. In contrast, high doses may alternatively cause “anxiety, nervousness, and jitteriness” as it “increases tense arousal” (Nehlig, 2010, p. 88). More specifically, Lieberman et. al. (1987) with the Department of Brain and Cognitive Sciences and the Clinical Research Center and the Department of Applied Biological Sciences found that “caffeine at all doses, even the lowest (32 mg), significantly improved performance on the modified [visual] vigilance test” (p. 310). Although the consumption of caffeine at all doses may be questionable, it is deducible from these two studies that caffeine improves attentiveness at low doses and may impair at high doses.

Albeit such benefits, long-term effects, regarding prolonged sleep latency, may prove harmful. Sleep latency, typically used when attributing the effects of sleep deprivation, refers to the duration in which an individual goes from fully awake to sleep. But, quite often, caffeine has “a larger and more persistent effect on the ability to stay awake” (Kelly, 1997, p. 399), which may have a greater impact on leading individuals to prolonged sleep latency even if they may use

it for the intended purpose of staying awake. Although many researchers strived to investigate the sleep latency after caffeine consumption, only a few went deeper to examine the effects of prolonged sleep latency caused by caffeine. Prolonged sleep latency can lead to delayed sleep phase disorder (DSPD), the “biologically mediated shift in sleep timing with a predisposition to a later sleep-wake cycle” (Kansagra, 2020, p. 205), as not being able to sleep for a longer period of time predisposes the circadian rhythm. Even though DSPD is investigated from the effects of sleep deprivation with pubertal onset, caffeine can induce more delay in the circadian rhythm as it prolongs sleep latency, ultimately deteriorating the capability to which people can go back to a normal sleep cycle. Because with less sleep comes exacerbated working performance, even if the short-term effects of caffeine on performance may prove beneficial, it is pertinent to account for the long-term effect.

Memory

Concerning academics, memory is needed not only for answering questions in tests but also for applying learned materials to any given task. Logically, as alertness and vigilant attention are impaired, it is virtually impossible to encode any materials as sleep is needed to not only consolidate new materials but prepare the brain to effectively retain them (Killgore, 2010, p. 116). In the findings of researchers Waters and Buck (2011), although there are varying results regarding short-term memory, there seems to be a general consensus that sleep loss negatively affects memory as it decreases response time and accuracy. To effectively obtain data on the impact of sleep deprivation on memory, researchers used an fMRI scan when testing the participants’ memory retention. The scan displayed that “the sleep-deprived group showed significantly less activation of the posterior hippocampus relative to the normally rested group,” indicating that sleep deprivation adversely affects the hippocampus, where the memory forms (Killgore, 2010, p. 117). Not to mention, positive and neutral memories were disrupted compared to the normally slept group who encoded both types (Killgore, 2010, p. 118). The hardship to encode materials into the brain, especially emotionally positive and neutral words, will, without doubt, hinder the learning process.

As sleep deprivation diminishes the ability to encode new information, whether or not caffeine aids memory retention should be investigated. According to Alhaider et. al. (2010), who aimed to explore the effects of spatial short term memory on sleep deprived and caffeine

consumed rats, although chronic treatment of caffeine on sleep deprived rats showed prevention of short-term memory, the chronic treatment on normal rats showed no significant effect (p. 439). Spatial short-term memory may not be as useful to determine students' academic performance; however, it does provide telling evidence of whether or not caffeine may help prevent the deletion of memory. Results from research conducted on humans show that caffeine facilitates memory to a limited extent inconsistently. Furthermore, caffeine only serves if "energetic supplies increase up to a certain level, beyond which it may deteriorate" (Nehlig, 2010, p. 87). These are all to say that caffeine most likely isn't going to foster or even detriment high school students' academic performance, especially when the work is heavily memory-dependent.

Mood

The mood is negatively affected by sleep deprivation which many concur in the research field. However, according to Pilcher and Huffcutt (1996), although the mood was significantly affected, the decrement in mood only played a marginal effect on performance. Despite this study, another claimed that the increased hours of sleep loss contributed to the increase in hostility towards others. Moreover, individuals were less willing to solve problems in given tasks (Kahn-Greene, 2006). While mood may be the most indirect out of the three factors in affecting adolescents' studies when in hostility, academic performance is only obliged to decline. Furthermore, as stated before, mood plays a role in memory as sleep deprived individuals are inclined to encode only emotionally negative words. The most important factors to account for in mood are disorders such as anxiety and depression. When depressed, minimal work gets done, and when anxious, insomnia can worsen. All these factors in the end affect students' academic performance as less systematic thinking takes place in a poor mood.

Caffeine's effect on mood also elicits varying results. According to Nehlig (2010), the mood is shown to change the most in the late morning when consumed in minimal amounts as "negative mood impact [is] associated with over-arousal" (p. 88). The more fatigue an individual is, the more positive mood changes he/she experiences throughout the day. However, other studies have shown distinct results. Many studies report that there are little or no differences between the self-reported mood scales before and after caffeine consumption (Lieberman et. al., 1987; Loke, 1988). Because mood can only be measured by self-reported questionnaires may be

conflicting as the participants might rate their current state more severely than others, it is important to have an in-depth analysis of how caffeine may or may not alter adolescents' mood.

All in all, the interconnected three factors seem to have an impact that leans more toward the negative spectrum. Because each factor has varying results from different studies, it is imperative to examine which effects apply to high school students. Furthermore, since most of the studies provided are on adults, conducting experiments and surveys is crucial to reach a correlation between the three cognitive factors and high school students' academic performance. For this study wishes to patch the gaps and aims to provide congruity between contrasting results from previous studies, this paper hopes to inspire further research, especially on high school students as they are the less-studied group in this area.

HYPOTHESIS

The researcher hypothesizes that high school students' academic performance will be heavily impaired by sleep deprivation. However, low levels of caffeine consumers will see benefits in helping their studies while the opposite will not. Working performance, memory, and mood will all be negatively impacted by sleep deprivation and the consumption of caffeine; however, working performance and mood may show to be the most as students are likely to stay up for a long period of time (even before the experiment is conducted) with consuming caffeine, which is likely to prolong their sleep latency, affecting the performance factor and increasing mood swings.

METHOD

In order to answer the research question effectively, the researcher targeted the participants with diverse backgrounds for this study. Unlike other research that does not study a heterogeneous sample (Ming et. al., 2011; Gau & Soong, 1995; Loessl et. al., 2008), this research focuses on students from Surabaya Intercultural School, an international school with students from various backgrounds, to lessen the gap of the unmeasurable effects from genes. To effectively measure the three cognitive factors, three instruments, the sleep journal, the MAZE passages, and a questionnaire, are implemented as a means of collecting qualitative and quantitative data.

Sleep Journal

The sleep journal is used for participants to record their sleeping hours, possible symptoms, caffeine consumption, and daily mood. The sleep diary is employed by researchers Loessl et. al. (2008) to solely obtain data on high school students' sleep patterns. However, as this study focuses on the three cognitive functions, participants should be required to not only record the amount of sleep and caffeine consumed but also document their mood or possible symptoms. Accordingly, the sleep journal will be an ideal measure to determine the sleep patterns due to sleep loss and the consumption of caffeine, conclusively allowing the analysis of the effect of prolonged sleep latency and the measurement of the cause and effect on their mood. As previously mentioned by research Sujay Kansagra, sleep latency is pertinent to examine as prolonged sleep latency can worsen performance. Also, because recording their mood is open-ended, there is also the possibility of obtaining a self-reported analysis on the theme of working performance.

MAZE Reading Assessments

Many studies have used a multitude of tests to measure working performance. For example, Pilcher and Walters (2010) used the Watson-Glasier Critical Thinking test to measure the cognitive performance of college students. Likewise, the researcher believes MAZE reading tests, "a task that measures how well students understand text they read silently" ("CORE Reading Maze Comprehension Test," p. 150), on high school students will elicit relevant outcomes as reading is an essential part in their learning and performing well on their studies. Furthermore, the Watson-Glasier Critical Thinking test may be difficult for high schoolers to complete in such a short period of time. Participants are required to take two of these assessments in order to compare the two results and determine the effect on students' cognitive performance in their sleep deprived state and their non-deprived state. The MAZE reading assessments contain a question that requires students to choose between three choices that fit the passage. Although the assessments require the time of three minutes, because the passages 10th to 12th-grade participants receive are in the 8th-grade level, the participants will receive two minutes to complete one.

Questionnaire

Asking participants to fill out a questionnaire or survey is a common approach in this field to obtain self-reported data. The self-reported data is primarily useful when assessing the participants' mood and effort when completing a task as only they can determine what they are feeling (Ming et. al., 2011; Pilcher & Huffcutt, 1996). However, the questionnaire is also going to be used to determine how and to what extent cognition, attention, understanding, and memory are affected by sleep deprivation and the consumption of caffeine with the account of other variables like age and the frequency of consumption.

The sleep journal and MAZE reading assessments will be taken in a span of 15 days. Although all the 17 participants who signed up using the consent form were obliged to complete them, one participant although started, didn't finish the sleep journal. Also, only 14 participants were able to complete the MAZE reading passages due to the difficulty of online learning. Fortunately, although not a profound amount, 30 participants filled out the form, allowing more possibility of finding the correlation. However, even with minimal participation, the researcher hopes it is still possible to obtain a general correlation that can contribute to the field of psychology.

Because of ethical measures, the Institutional Review Board (IRB) declined the researcher's initial method of conducting an experiment that required participants to sleep a specified amount of hours. Also, asking if their school grades went down like researchers Ming et. al. would not only raise ethical concerns but also be ineffective as nothing might change during the short time this is taking place. As a solution, the aforementioned sleep journal, reading tests, exit tickets, and self-reported questionnaire. Although this is a viable solution, the reading test, having to take one in a normal state and another in a sleep deprived state, might raise concerns. The researcher wishes to make clear that she will not be asking the participants to be sleep deprived more a specific amount of hours; instead, she will ask them to sleep for more than 8 hours when taking the test in a normal state for no more than 6 or 7 hours when taking the test in the sleep deprived state. As participants are suggested to be sleep deprived and not consume caffeine and are required to fill out a consent form that entails their and their parents' permission, they will be joining this experiment by will, which should raise no further ethical concerns.

RESULTS

Before analyzing the implications of the data, organizing the qualitative and quantitative comes first. The participants are addressed in alphabet letters and numbers to keep them anonymous due to ethical reasons. Each alphabet and number represents the same person; so, A is addressing the same person in Table 2a and Table 2b, and the same goes for numbers in tables 1 and 3. Table 1 is a summary of the sleep journal that provides some accounts of what the majority of the participants felt. Tables 2a and 2b are the results from the MAZE passages that are meant to be compared to each other for implications. Graphs 1a and 1b show the average of cognition, attention, understanding, and memory, with a 5% error bar of the ratings from 1-10. Table 3a is the account of all participants in the questionnaire that asks about the frequency of caffeine consumption, whereas Table 3b inquires about how that affects their studies.

Table 1a. Sleep Journal Summary

Ages	Hours Slept (Average)	Hours Slept (Standard Deviation)	Status	Mood
18	6.12	0.98	Sleep Deprived	Insomnia, sleepy, tired, not alert, stressed, anxious, hyped up, not tired, energized
			Sleep Deprived with caffeine	Awake, okay, light headache, distracted
	8.4	0.53	Not Sleep Deprived	Okay, tired, awake, exhausted, burnt out, happy, disturbed sleep
17	5.69	1.36	Sleep Deprived	Tired, fatigue, burnt out, unconcentrated, moody, sluggish, excited, ready, headache
			Sleep Deprived with caffeine	Normal, energetic, awake, relaxed, motivated
	8.6	0.66	Not Sleep Deprived	Relaxed, tired, concentrated, unconcentrated, sleepy
16	5.82	6.77	Sleep Deprived	Tired, sleepy, drowsy,

				mood swings, unmotivated, muscle pain, accidental sleep
			Sleep Deprived with caffeine	Tired, energetic, awake, relaxed, motivated, anxious, loud heartbeats
	8.63	0.64	Not Sleep Deprived	Tired, energetic, relaxed

*few exceptions of people who consumed caffeine all the time

Table 1b. Sleep Journal Summary

% of Participants*	General Sleeping Patterns and Frequency of Caffeine Consumption	Mood/Possible Symptoms
29.4%	≥ 5 hours sleep, rarely consume caffeine	Tired, stressed, unconcentrated, dizzy, insomnia, headache
41.2%	< 5 hours sleep, rarely consume caffeine	Fine, tired, sleepy, okay
0%	≥ 5 hours sleep, sometimes consume caffeine	-
5.88%	< 5 hours sleep, sometimes consume caffeine	Fatigue, drowsy, lazy, lethargic
0%	≥ 5 hours sleep, almost always consume caffeine	-
23.5%	< 5 hours sleep, almost always consume caffeine	Happy, energized, tired, sluggish

*the percentages are only an approximation

Table 2a. MAZE Passages: Participants with sleep deprivation

Participants	Hours Slept	Wrong	Omitted	Correct
A	5	5	18	24
B	8	12	28	12
C	7	2	36	9
D	6	0	21	26
E	6	2	26	19
F	2	1	25	21
G	5	0	33	14

H	6	0	30	17
I	4	0	27	20
J	3	2	25	20
K	7	1	22	24
L	4	1	18	28
M	5	1	28	18
N	1	1	22	24

Table 2b. MAZE Passages: Participants with no sleep deprivation.

Participants	Hours Slept	Wrong	Omitted	Correct
A	7	6	15	26
B	8	4	25	18
C	8	6	23	18
D	7	2	7	38
E	9	1	24	22
F	9	4	11	32
G	7	1	26	20
H	8	4	21	22
I	8	1	18	28
J	8	4	6	37
K	8	2	19	26
L	8	1	16	30
M	6	1	25	21
N	12	7	14	26

Table 3a. Self-reported Questionnaire: Qualitative Data

Indivi- duals #	Do you usually drink caffeine after being sleep deprived?	How much caffeine do you drink? Do you drink it even when you're not sleep deprived? Are you sleepy in the daytime?
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1	Yes	I always drink a cup of coffee in the morning, and if I drink more it is before 12pm
2	Yes	I usually drink 1-2 cups
3	Yes	I drink caffeine once in a while. Sometimes I'll take drinks with caffeine for the taste even when I'm not sleep deprived, and I'm sleepy in the daytime.
4	Yes	Depends. I drink it whenever I'm sleepy. Generally 2-3 shots of espresso. I am sleepy in the daytime.
5	Yes	1 to 2 cups of coffee a day
6	Yes	I drink caffeine every morning and sometimes at night I have to study. I am sleepy in the daytime if I don't drink coffee.
7	Yes	Not that much, maybe a couple times a week. Yes, I do drink it when I'm not sleep deprived. Yes, I am sleepy I'm the daytime.
8	Yes	I drink three cups of coffee everyday. I drink it on a daily basis, even though I am not sleep deprived. I usually sleep in the afternoon if I don't drink coffee.
9	Yes	I usually drink tall size Americano. I don't drink coffee when I am not sleep deprived. I am always sleepy both during the day and night.
10	Yes	I drink it only when I need it. I drink at most only one cup of coffee. Yes, I am sleepy during the daytime.
11	Yes	2 shot of espresso/no/yes
12	Sometimes	I don't usually drink caffeine during the night time but usually after school. I get sleepy during the daytime but my consumption of caffeine is not that much.
13	Sometimes	I consume caffeine almost everyday, yes I do drink it when I'm not sleep deprived, and sometimes I could be sleepy in the daytime.
14	Sometimes	A cup of coffee in the morning, I do not drink when I'm not sleep deprived, I am sleepy in the daytime.
15	Sometimes	(1) probably 2 shots a day when I do drink (2) yes (3) yes
16	Sometimes	I drink caffeine only when I want to. I drink caffeine even when I'm not sleep deprived. I feel sleepy in the daytime only when I'm sleep deprived.
17	Sometimes	I drink a cup of coffee. Sometimes. Yes, often.

18	Sometimes	Around 250ml, I drink coffee almost everyday. Sometimes, I am sleepy in the day after I drink coffee
19	Sometimes	I barely drink caffeine. I drink it when I'm not sleep deprived. Yes, I am sleepy in the daytime.
20	Sometimes	4-5 times a week. Yes. Most of the time.
21	Sometimes	Not a lot.
22	Sometimes	5g of caffeine (Nescafe 240mL). I drink even if I don't feel sleep deprived. Sometimes I feel sleepy after lunch.
23	No	I drink several glasses of tea. I drink it when I am not sleep deprived, it's a common beverage for me. I am sleepy in the daytime especially when I stay up late for several days in a row.
24	No	Not that much, I just drink tea when I feel like it.
25	No	I consume caffeine frequently throughout the week but not everyday. Since it doesn't help me stay awake and focus, I rarely drink it when I'm sleep deprived. Yes, I am often sleepy in the daytime.
26	No	About 2-3 cold brew mugs per week. I usually drink after school as a refreshing beverage.
27	No	I don't drink much caffeine, maybe once every 2-3 days. Yes, I drink coffee or tea when I'm not sleep deprived. I am always sleepy in the daytime.
28	No	I don't drink caffeine at all. But, I do get sleepy at times during the day however I just try my best to stay up.
29	No	I drink one cup a day. I drink even when I'm not sleep deprived and I'm still sleepy in the daytime.
30	No	I drink caffeine about once a week. I drink it even when I'm not sleep deprived. I always sleep late, so I feel sleepy during the daytime.

Table 3b. Self-reported Questionnaire: Qualitative Data

Individuals #	Do you think you score well on assignments and/or tests after drinking caffeine after sleep loss?	How does caffeine help/not help you in your studies?	Does caffeine prevent you from falling asleep at night or delay the timing of your sleep?
1	No	It does not have a specific effect, but too much caffeine makes me distracted.	No

2	Yes	It aids my late night study.	Yes
3	No	It doesn't help me.	No
4	Maybe	It's alright; it helps me stay awake but sometimes races my heartbeat to a point where I can't focus.	Maybe
5	Yes	It gives me energy.	Yes
6	Yes	Wakes me up to be more attentive in class.	Yes
7	No	It doesn't really help much, but it does give me some energy to study	No
8	Maybe	Caffeine seems to help enhance my memory and retention skills. It also helps me stay concentrated during long study sessions which I find hard to stay focused without coffee. It also has other positive effects, such as boosting my mood when I get tired of studying.	Maybe
9	Yes	They help me study awake, which enables me to study. Although my attention level is lower than usual, I still drink caffeine to study.	Yes
10	Yes	It helps me focus as I don't feel sleepy anymore. I feel more awake.	Yes
11	Maybe	Not sure	Maybe
12	Maybe	It only helps to a certain extent as it does help me stay awake sometimes. However, the effects are not always strong enough to keep me awake.	Maybe
13	No	So far, I haven't noticed any specific help towards anything from caffeine consumption.	No
14	No	It helps me stay awake and pay attention, however retaining information and recalling memory becomes slightly more difficult.	No
15	I think I score the same	It helps me become motivated to work	I think I score the same

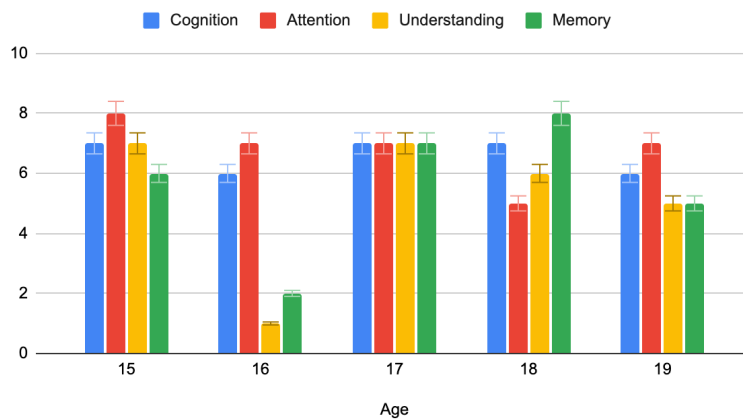
	whether I have caffeine or not.	in that when I have any beverage I like to drink, working seems doable. I think I get more attentive when I do work, but it doesn't affect my memory.	whether I have caffeine or not.
16	No	Caffeine helps me be more attentive to my task at hand, but it also causes me to become more jittery. With caffeine, I finish a task faster but with minimal effort. I do tasks without thinking too much and rush to get things done, causing me to forget what the task is actually all about.	No
17	Maybe	Caffeine makes me not fall asleep while studying.	Maybe
18	No	It help me to understand studies(classes) a lot	No
19	Maybe	Caffeine doesn't affect my study habits	Maybe
20	No	It does help me to stay focused and aware when it comes to studying especially when I'm staying up late	No
21	Maybe	It helps me focus	Maybe
22	Maybe	It only helps me stay awake at night so I have more time to study.	Maybe
23	Maybe	I do not consume caffeine for my studies. I never drink coffee but I drink tea like it's water. I don't expect any positive or negative effects.	Maybe
24	No	It helps me to focus more	No
25	No	It does not affect me very much as I feel the same after consuming caffeine.	No
26	Maybe	Caffeine does make it possible for me to stay awake for studies in the evening. However, it only gets rid of the sleepiness I am experiencing and retains the tiredness. This makes my memory and attentiveness to what I am studying the equivalent of being in the school's	Maybe

		last period.	
27	No	It affects my energy as sometimes I get bored and my attention span gets worse during tests.	No
28	No	It does not help.	No
29	No	It affects me on remembering things more clearly than not drinking caffeine.	No
30	Maybe	When I take caffeine, I feel sleepy, but I can't sleep and my body keeps getting tired, so it's painful.	Maybe

Graph 1a. Self-reported Questionnaire: Quantitative Data

Average of Cognition, Attention, Understanding, and Memory, vs. Age (Error bar: 5%)

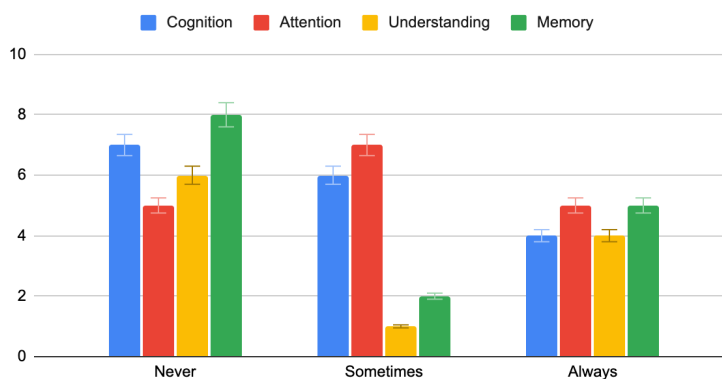
Cognition, Attention, Understanding, and Memory vs. Age



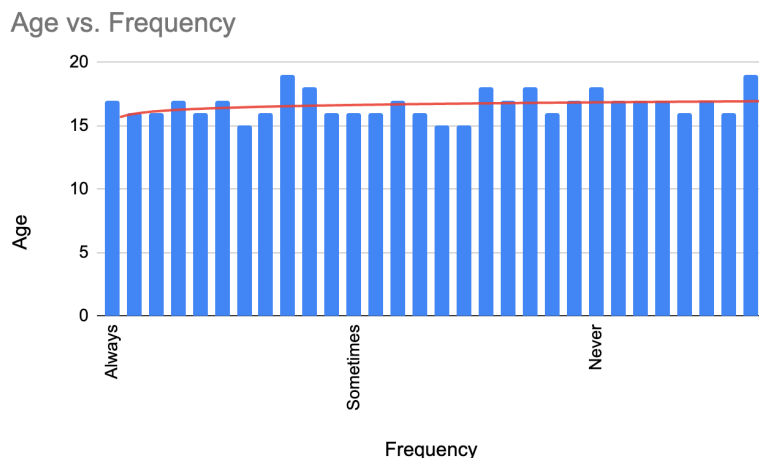
Graph 1b. Self-reported Questionnaire: Quantitative Data

Average of Cognition, Attention, Understanding, and Memory, vs. Frequency (Error bar: 5%)

Cognition, Attention, Understanding, and Memory vs. Frequency



Graph 2. Self-reported Questionnaire: Quantitative Data (Age vs. Frequency)



DISCUSSION

Although the small sample size gives it little diversity for observation of extraneous but impactful variables like age and genes, the results give telling evidence and implications for the effects on high school students' studies from sleep deprivation and the consumption of caffeine. To answer the research question effectively by analyzing the results, the discussion is separated into three categories as organized before: working performance, memory, and mood. The three categories will focus more closely on the frequency as it is the variable that shows the most positive correlation between the rest of the dependent variables.

The reason why focusing on the frequency variable is most influential is because when comparing the age to the cognition, attention, understanding, and memory of participants, it is difficult to find a general correlation (Graph 1a); however, when comparing the frequency of those variables, the correlation is more defined (Graph 1b). Examining Graph 2 gives the reason for the lack of correlation when comparing the age. Age has nothing to do with how much a person drinks. Therefore, the frequency will be focused on the three aforementioned variables: working performance, memory, and mood.

Working Performance

In trying to obtain data on how the impact of working performance from sleep deprivation and the consumption of caffeine affects high school students' academic performance, the data from the three instruments should be thoroughly discussed. Because the qualitative data of the self-reported questionnaire and sleep journal gives insight into what participants believe, the quantitative data of the MAZE reading passages may provide confirmation. The summary of

the sleep journal (Table 1a), although doesn't offer much about the working performance, implies that it is impaired through the three circumstances (sleep deprivation, sleep deprivation with caffeine, and no sleep deprivation) as their fatigue lasts the next day or two after sleep deprivation. However, some recorded with more positive words like awake and happy in non-deprived and caffeine consumed days and stressed, not alert, and unconcentrated in deprived days. The negative mood accounts for the working performance as their concentration and effort will wane (Kahn-Greene, 2006). Because the sleep journal is only in a span of 15 days, future research should take on a longer period of time to further verify this finding.

In the self-reported questionnaire, in terms of the ratings from 1-10 on how much they felt that caffeine enhanced their cognitive function, the results increasingly went down, meaning more frequent doses of caffeine gives a plateau in working performance. However, participants who rarely and always consumed caffeine after sleep deprivation rated a five in attention, whereas participants who sometimes consumed rated a seven. This could imply that constant doses of caffeine don't affect their attention positively while too little caffeine doesn't help, which is synonymous with previous findings. The qualitative data concerns comparing the frequency of caffeine consumed with the impacts on their studies. The data highlight the fact that people who generally selected the low consumption of caffeine saw no effect in their studies, implying that those participants recently stopped consuming caffeine as they saw no effect as studies previously mentioned argued that caffeine helps in low doses. Furthermore, those who always consume caffeine confessed that "[i]t does not have a specific effect, but too much caffeine makes me distracted" and "it helps me stay awake but sometimes races my heartbeat to a point where I can't focus." This report aligns with the findings of Nehlig (2010) as they both conclude that high doses of caffeine don't elicit good results; however, low doses of caffeine may not be more effective for high school students than it is proved to have been for adults.

Although the self-reported questionnaire can't be completely trusted as some people may take a feeling greater than others and the data takes the average with an error bar of 5%, the MAZE reading assessments may help confirm or disprove the previous analysis. By comparing Table 1a and Table 1b, it is identifiable that sleep deprivation worsens the cognitive abilities of the participants with few exceptions. Hence, it is evident that sleep deprivation impairs the working performance of individuals. However, because the participants weren't tested on the

effects after the consumption of caffeine because of the lack of time, future research should go on and do so.

Memory

Memory can be assessed using the quantitative data of the self-reported questionnaire. Although there isn't another measure to confirm the participants' ratings, because the participants have gone through years of memory independent and dependent tests, trusting their ratings and filtering out the purported cause of such ratings are acceptable. Graph 1b shows that memory is heavily affected by sleep deprivation with minimal effect shown when participants sometimes and always consume caffeine. The unanticipated result is that more participants that consume caffeine sometimes saw less effect in caffeine after being sleep deprived than the ones who always consumed caffeine. Although the fact that participants who rarely consume caffeine even when sleep deprived saw more benefits in helping with memory retention than the other two is synonymous with the aforementioned research (Nehlig, 2010), the lower benefit from participants who only consume caffeine sometimes goes against the general consensus. This implies that either the participants who sometimes consume caffeine selected the extent to which they were affected by caffeine rated more harshly than the ones who always consume caffeine or the students between the age of 15-19 experience fewer benefits when consuming caffeine sometimes than ones who consumed all the time.

Mood

As established by previous research analysis, sleep deprivation shows a negative correlation with mood while the result from caffeine consumption is arbitrary. Although the discourse of the summary of the sleep journal (Table 1a) was pertinent in measuring the working performance, it would be most beneficial to look at the specific condition for the effects of mood. Table 1b shows that the mood of the participants who rarely consume caffeine and whose hours of sleep isn't far off the recommended hour of sleep isn't so negatively affected compared to the ones who slept less than or equal to five hours, one stating "I'm still feeling very anxious and jittery this morning though." This outcome is axiomatic considering the findings of previous studies that all reached a consensus on the impairment of sleep deprivation. The participants who consumed caffeine almost daily saw more positive mood results than the ones who sometimes or

rarely consumed it. Although the participants who always consumed caffeine felt happy and energized on not-deprived days, stating “I felt fresh and calm,” they also felt sluggish and tired when they were sleep deprived, quoting “I feel happy and energized but sometimes moody or annoyed easily.” Despite the fact that there is only one person that slept a little more than five hours and sometimes consumed caffeine, it is deduced that that participant still feels drowsy and lazy even with the consumption. These accounts suggest that caffeine doesn’t give high schoolers a profound effect on their mood or their cognitive state.

These findings clear up the discrepancies between the findings on whether caffeine help stimulates positive mood or not. Caffeine doesn’t seem to have a negative impact on mood; however, it might not be helpful for daily consumers and consumers of high doses as some recorded the heightening of anxiety and increase of loud heartbeats; this outcome is also synonymous with the finding of Nehlig (2010) who argued that caffeine only in low doses helps overcome negative mood. In support of the findings of Liebermann et. al. (1987), although caffeine may help induce a positive mood, it doesn’t have a profound effect on high school students.

CONCLUSION

There are a few limitations future researchers could take into account. First, the sample size itself is very small, giving leeway to find a strong correlation. Because this was conducted specifically in Surabaya Intercultural School and was an experiment that lasted for 15 days, it didn’t attract many people. For a bigger sample size, researchers should branch out to other schools in the specific region of interest and maybe offer incentives. Also, researchers should ask the participants to fulfill all the requirements when signing up as some participants weren’t able to do the MAZE reading passages as online learning made it difficult. Because every participant has a different personality and some might value a certain aspect higher than others, the average ratings may be affected by some outliers. In particular, some people may rate the effect on cognition higher than others who purportedly could have had the same magnitude of impact. Although hopefully, other instruments could cover up the self-reported questionnaire, because of limited time, only measuring the sleep deprived and not deprived states was possible (not accounting for the caffeine consumption). Because of these biases, future researchers should conduct reading assessments in the three states: not deprived and sleep deprived with and

without caffeine consumption. Furthermore, since memory was only measured using the self-reported questionnaire, researchers should develop a memory test and use the fMRI like researcher Killgore (2010) did; however, that method should be employed for high school students.

From the results of this paper, it is deducible that sleep deprivation impairs all three factors that ultimately hinder the studies of high school students. Caffeine is beneficial sometimes in low doses and may reach a plateau or not give any benefits when consumed daily. However, caffeine is harmful when consumed in high doses as it raises anxiety. This finding implies that although caffeine may not be detrimental, it doesn't help the learning of high schoolers. That is why it is vital to not be sleep deprived and depend on caffeine. It is also important for researchers to account for other variables as working performance, memory, and mood aren't all that affect high school students' performance. Because of such impairment, actions schools can take are delaying the start of school time and educating students about the effects. Possible solutions individuals can implement in their lifestyle are trying to follow a healthy sleep schedule and attempting to avoid consuming caffeine in high doses. Such solutions could lead to the heightened academic performance of high school students.

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Appendices

Appendix 1. Consent Form

Consent Form

Event time: March 9-23
Contact me at yepark@sis.sch.id

Please fill this out if you are interested in participating. Thank you.

Your email will be recorded when you submit this form

* Required

Student's Full Name *

Your answer

Email *

Your answer

Grade *

Choose ▼

Permission *

The student's parents should fill this out.

☐ My child is allowed to participate in this experiment.

☐ My child isn't allowed to participate in this experiment.

Consent Form

Please continue if you wish to participate.

I understand the participant is subject to side effects. *

☐ Yes

☐ No

I understand the participant is to follow directions and to be honest throughout *
the course of experiment.

☐ Yes

☐ No

☐ Other: _____

Any other comments...

Your answer

Appendix 2. Self-reported Questionnaire

Sleep Deprivation and the Effects from Caffeine

Please answer these questions in the scenario of being SLEEP DEPRIVED and with consumption of CAFFEINE. For further inquiry please contact yepark@sis.sch.id

Your email will be recorded when you submit this form

* Required

How old are you? *

Choose ▼

What form of caffeine do you consume? *

☐ Coffee

☐ Tea

☐ Soft Drinks

☐ Other: _____

Do you usually drink caffeine after being sleep deprived? *

☐ Yes

☐ No

☐ Sometimes

☐ Other: _____

After drinking caffeine in the sleep deprived state, to what extent do you think it enhanced your cognitive functions?

1 2 3 4 5 6 7 8 9 10

No effect ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Profound effect

Do you think you score well on assignments and/or tests after drinking caffeine after sleep loss. *

- ☐ Yes
- ☐ No
- ☐ Maybe
- ☐ Other: _____

How does caffeine help/not help you in your studies? *

Please write this in specific details. You can mention how it affects your memories, vigilant attention, and etc.

Your answer

To what extent does caffeine help you be more attentive when sleep deprived? *

1 2 3 4 5 6 7 8 9 10

No effect ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Very attentive

To what extent does caffeine help your understanding in a subject or concept after sleep deprived? *

1 2 3 4 5 6 7 8 9 10

No effect ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Profound effect

To what extent does caffeine help with your memory after sleep deprived? *

1 2 3 4 5 6 7 8 9 10

Doesn't help ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ Helps a lot

Does caffeine prevent you from falling asleep at night or delay the timing of your sleep? *

☐ Yes

☐ No

☐ Sometimes

☐ Other: _____

How much caffeine do you drink? Do you drink it even when you're not sleep deprived? Are you sleepy in the daytime? *

Please answer all three questions. Thank you.

Your answer _____

Appendix 3. MAZE Reading Assessment #1

Mr. Mooney is an expert at his occupation. In fact, he is one of **(has, and, the)** few experts left in an occupation **(this, that, right)** is slowly dwindling and lacking well-**(finished, trained, can)** professionals.

Mr. Mooney shampoos animals. He **(were, finished, is)** known to boast that there is **(in, one, no)** animal too filthy, too big or **(too, is, all)** wide, and no animal too ferocious **(to, an, for)** him. He can get them all **(polished, top, clean)** and contrite. Mr. Mooney has the **(right, bristly, week)** to boast.

Once, when Mr. Mooney **(top, is, was)** younger, he was called upon to **(shampoo, polished, beauty)** the walruses at the local zoo. **(That, When, If)** Mr. Mooney was finished with those **(heads, walruses, next)**, their bristly coats were gleaming, their **(remained, roof, tusks)** were polished to perfection, and the **(next, gleaming, few)** hairs they possessed on the top **(of, the, for)** their heads were fit for a **(assistant, younger, beauty)** pageant.

The next week, the zookeeper **(were, that, was)** heard whispering to his assistant that **(the, for, and)** walruses that were usually crabby and **(impolite, terrible, even)** were unusually courteous and kind. According **(to, their, at)** the zookeeper, they remained that way **(start, from, for)** an entire week after Mr. Mooney **(with, had, have)** soaped them up and washed them **(over, heard, down)**. Rumor has it that whenever they **(give, see, for)** someone coming at them with a **(scrub, filthy, even)** brush and a bar of rose-**(coated, scented, animal)** soap, they start to squeal with **(glory, everywhere, delight)**, flip over on their backs, and **(wag, fit, squeal)** their tails in excitement.

Whenever the **(perfection, walruses, zookeeper)** are brought up, Mr. Mooney smiles. **(Yes, Fact, Arrived)**, they were a triumph for him, **(he, but, been)** if asked what his most memorable **(help, to, job)** was, he will tell you about **(them, the, impolite)** time he was asked to groom **(her, Mrs., rose)** Richman's peacocks. Even to this day, **(those, when, were)** Mr. Mooney recalls the sight that **(greeted, spilled, brush)** him when he arrived at Mrs. **(Mooney, flip, Richman's)** mansion, he shudders.

Apparently there had **(been, at, spilled)** a terrible accident while some workers **(polished, were, was)** repairing Mrs. Richman's roof and tar **(coats, been, had)** spilled everywhere. As Mr. Mooney drove **(finished, up, smiles)** to her large house, he couldn't **(help, boast, sight)** but gasp at the flock of **(walruses, polished, peacocks)** coated in a thick, black mess. **(Mansion, Remained, Their)** beautiful plumage was black and their **(hairs, eyes, large)** were tragic and downcast. Never one **(to, at, coated)** give up or despair, Mr. Mooney **(greeted, feathers, climbed)** out of his van and went **(on, to, they)** work.

Appendix 4. MAZE Reading Assessment #2

Tyler paused as he picked an apple and looked up at the blue sky. He loved living on an apple (**famous, orchard, tree**). He didn't even mind the nuisance (**of, or, from**) setting his alarm clock for five (**p.m., a.m., was**) every morning during the months of (**busy, year, August**) through October because of harvest season.

(**And, The, At**) orchard's busy season was in the (**day, fall, rainy**), when people came from all over (**the, an, it**) country to pick their own baskets (**since, of, in**) apples, take a ride on the (**hay, delicate, spring**)-filled wagon, or purchase a couple (**at, this, of**) jars of the orchard's famous apple (**tree, pick, jelly**). There were also pony rides and (**marshmallow, late, bees**) roasts, all of which Tyler enjoyed. (**He, However, Because**), the orchard was his main concern, (**and, but, use**) it required year-round maintenance.

In (**a, the, his**) early spring and late autumn, every (**people, apple, old**) tree in the orchard needed to (**also, was, be**) pruned. This was a tedious job (**leave, so, that**) Tyler performed himself since pruning trees (**required, main, treated**) a delicate touch. Most rainy spring (**old, mornings, flowers**), Tyler could be found driving around (**a, in, the**) orchard on his tractor. He would (**round, cut, stop**) at every tree and use his (**hydraulic, tedious, maintenance**) tree-clipper to cut back excess (**growth, and, tree**).

The key was to leave enough (**were, apples, buds**) so the apple tree would produce (**not, adequate, old**) fruit, but not so many buds (**so, that, for**) the tree would collapse under the (**age, much, weight**) of its own abundance. Many of (**the, a, no**) fruit trees in Tyler's orchard were (**over, under, spring**) seventy-five years old, which was (**an, also, a**) ripe old age for an apple (**orchards, tree, treated**).

In the spring, the trees would (**delicate, bloom, collapse**) in white and pink flowers and (**last, a, the**) bees would come to pollinate. Bees (**were, such, would**) treated with much respect and reverence (**at, for, day**) the orchard, because if it were (**wide, over, not**) for the bees, there would be (**not, hoped, no**) pollination and thus, no apples. Spring (**few, was, were**) also when new seedlings were put (**into, variety, back**) the ground.

Last year, Tyler planted (**an, a, in**) variety of new apple trees—Ginger (**another, pink, Gold**), Golden Delicious, Empire, Liberty, and Rhode (**year, Island, first**) Greening, just to name a few. (**It, He, His**) hoped that one day his orchard (**would, was, thus**) produce such a wide variety of (**planted, apples, flower**) that he would be able to (**start, main, produce**) his own cider company.

For now, (**people, take, Tyler**) thought as he picked another apple, he'd just focus on his first love, his apple trees.

Appendix 5. Sleep Journal Template

Sleep Deprivation Schedule

Please fill out the boxes below. Possible symptoms include DSPD, circadian rhythm disorders, insomnia, depression, etc... Please feel free to include any other symptoms you suspect to have. Please identify the amount of caffeine consumed if any. Please be descriptive when filling out how you feel each day (Could you pay attention in class? Can you recall concepts or formulas you learned today? Did you sleep or almost fall asleep in class? How tired were you compared to the day before?).

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9					
Mar 10					
Mar 11					
Mar 12					
Mar 13					
Mar 14					
Mar 15					
Mar 16					
Mar 17					
Mar 18					
Mar 19					
Mar 20					
Mar 21					
Mar 22					
Mar 23					

* Possible symptoms from sleep deprivation. (If you aren't sure which one to use, please either contact me or just describe what you felt).

Delayed sleep-wake phase disorder (DSPD): a disorder in which a person's sleep is delayed by two or more hours beyond the socially acceptable or conventional bedtime

Circadian rhythm disorders: difficulty falling asleep, waking up during the sleep cycle, or waking up too early, and being unable to fall back to sleep

Insomnia: hard to fall asleep

Depression: a serious illness that negatively affects how you feel and act

Appendix 6. Sleep Journal: Participant A

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	7 hours		O	1 cup	Awake but needed a walk to feel more energized
Mar 10	6 hours		O	1 cup	Somewhat distracted in class; had trouble staying focus.
Mar 11	6 hours		O	2 cups	Mostly sleepy, did not feel very energized.
Mar 12	8 hours		O	1 cup	Quite productive and was physically active
Mar 13	5 hours		O	2 cups	Tried to study, found it difficult to concentrate. Lots of walking in a day; felt drained.
Mar 14	6 hours		O	1 cup	Sleepy after lunch, energized during basketball
Mar 15	6 hours		O	2 cups	Felt energized during basketball and classes, overall focused.
Mar 16	5 hours		O	2 cups	Mostly focused during class, felt productive
Mar 17	7 hours		O	1 cup	Lethargic throughout the day

Mar 18	7 hours		O	1 cup	Motivated to do some work at school, went home and felt relaxed
Mar 19	9 hours		X		Awake but tired (?) in a sense that I was mostly lazy throughout the day
Mar 20	7 hours		O	1 cup	Energized and motivated
Mar 21	7 hours		O	1 cup	Mostly focused on reading, had lots of physical activity
Mar 22	8 hours		X		A balanced day of being productive and resting, peaceful.
Mar 23	6 hours		O	1 cup	Relaxed and had a lazy day

Appendix 7. Sleep Journal: Participant B

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	9.5		O	1 Cappuccino	Tired (from yesterday's sports)
Mar 10	8.5		O	1 Cappuccino	Tired from period
Mar 11	7.5		O	1 Cappuccino	Tired from period
Mar 12	8		O	1 Cappuccino	Tired from walking and period
Mar 13	9		O	1 Cappuccino	Tired because of morning walk
Mar 14	9		O	1 Cappuccino	Tired because not enough food from breakfast
Mar 15	8		O	1 Cappuccino	Tired from swimming

Mar 16	8.5		O	1 Cappuccino	Tired from basketball
Mar 17	8		O	1 Cappuccino	Tired in the afternoon
Mar 18	9		O	1 Cappuccino	Short bursts of energy
Mar 19	7		O	1 ice latte	Tired
Mar 20	8		O	1 cappuccino	Tired
Mar 21	8		O	1 cappuccino 1 english breakfast	Energetic
Mar 22	8.5		O	1 cappuccino	Tired from workout
Mar 23	9		O	1 cappuccino	normal

Appendix 8. Sleep Journal: Participant C

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	7 hours 30	No symptoms	×		Okay
Mar 10	8 hours	No symptoms	×		Okay
Mar 11	7 hours	No symptoms	×		Okay
Mar 12	9 hours	No symptoms	×		woke up tired
Mar 13	8 hours	No symptoms	×		Okay
Mar 14	6 hours 30	No symptoms	×		sleepy and tired
Mar 15	7 hours 30	No symptoms	O	1 time, a cup	Okay
Mar 16	8 hours	No symptoms	×		Okay
Mar 17	8 hours	No symptoms	×		okay
Mar 18	8 hours	No symptoms	×		Okay
Mar 19	8 hours 30	No symptoms	×		Okay
Mar 20	9 hours	No symptoms	×		Tired

Mar 21	9 hours	Circadian sleep-wake phase disorder	×		Okay
Mar 22	9 hours 30	No symptoms	×		Okay
Mar 23	7 hours	DSPD	×		Okay

Appendix 9. Sleep Journal: Participant D

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	4 hours	Insomnia, bad mental health, physically feeling unwell	X		I'm not as alert as I usually am. By lunch time my sleepiness started to kick in and I couldn't concentrate during my last two classes. I ended up taking a 2-hour nap (which I rarely ever do) after school ended.
Mar 10	4 ½ hours	Insomnia, stress	X		I was fine during the first two periods of school but got sleepy in periods 3 and 4. I am more sleepy today than I was yesterday.
Mar 11	5 ½ hours	Insomnia	X		I got a somewhat decent amount of sleep (just had to finish off homework last night) so I'm feeling alert today.
Mar 12	7 hours	Apathetic ?	X		I finished my homework yesterday so I don't have anything much to worry about today, leading to me sleeping in and getting more rest than usual
Mar 13	9 hours	Well-rested	X		I forgot to turn my

		sleep			alarm on so I overslept. But I feel really alert and focused today (other than the fact that I'm starting to overthink how the rest of this week will go)
Mar 14	5 hours	Anxiety, insomnia, overthinking	X		I had to write my AP Lang timed argument essay this morning and I was extremely stressed and started overthinking. The rest of my day went okay but I felt unmotivated because it's a Monday :)
Mar 15	6 hours	Anxiety, overthinking	X		I slept for two hours and couldn't sleep for a while before sleeping another four hours. I was stressing about an assignment so I couldn't stay asleep at first. I'm still feeling very anxious and jittery this morning though.
Mar 16	9 hours	Exhaustion	X		I think my burnout finally got to its limit and I was extremely tired so I slept a lot longer than usual. I definitely feel really refreshed and alert in my classes today.
Mar 17	6 hours	Insomnia, stress from homework	X		I feel pretty decent today. Sleeping for an average of 6 hours is kind of the norm for me at this point so I don't feel very tired.
Mar 18	6 ½ hours	Probably just because I'm used to sleeping at a	X		I feel good today. So far I've been alert and awake in my classes.

		certain time and now I can't sleep before that.			
Mar 19	7 hours	Haven't felt this relaxed in a long time	X		I feel really good since it's the first day of spring break. I was up and alert.
Mar 20	7 ½ hours	More apathetic than yesterday but nothing extreme	X		Same as yesterday, still alert enough to work on spring break homework but got slightly anxious about university but overall my day went okay.
Mar 21	6 hours	Anxiety	X		Feeling a bit gloomy today, but I was able to get quite a bit of my homework done.
Mar 22	8 hours	Relaxed	O	I had about 5 or 6 spoons of coffee ice cream (idk the exact caffeine measurement though, sorry!)	I feel okay. I was awake the whole day but wasn't as productive as I was planning to be.
Mar 23	7 hours	Excited	X		Felt awake and happy.

Appendix 10. Sleep Journal: Participant E

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	7hrs	PMS	O	200ml coffee 1x	Not physically tired but mentally; shorter time to be focused entirely on my work
Mar 10	8-9hrs	Slight headache from PMS	O	200ml coffee 1x	Mentally a bit tired but easier to concentrate on work than yesterday

Mar 11	6hrs	nothing	O	200ml coffee 1x 400ml cola	Focused and faster processing of information; clearer mind
Mar 12	8hrs	nothing	O	500ml coffee 1x	Relaxed, easily focused on things I need to get done (english hw)
Mar 13	9hrs	nothing	O	200ml coffee 1x	distracted
Mar 14	6hrs	Light headache from too little sleep	O	200ml coffee 1x	Easily focused but hard to remember certain things, tired
Mar 15	8-9hrs	Nothing	O	200ml coffee 1x	Less tired than yesterday, hard to focus, distracted by personal matters
Mar 16	8hrs	Nothing	O	200ml coffee 1x	More energized, more focused in class than yesterday, could easily come up with answers for questions I didn't prepare for
Mar 17	9hrs	Nothing	O	200ml coffee 1x	Clear minded, completely focused on tasks and fast to finish work.
Mar 18	5hrs	nothing	O	350ml coffee 1x	Alert and awake but with stinging eyes
Mar 19	9hrs	Nothing	O	700ml coffee	Relaxed, didn't needed to focus on anything specific
Mar 20	8hrs	Nothing	O	750ml coffee	Tired but relaxed
Mar 21	8hrs	Nothing	O	450ml coffee	Relaxed, alert of surroundings, nothing needed to focus on academic wise
Mar 22	9hrs	Nothing	O	150ml coffee	Relaxed, no needed to focus
Mar 23	10hrs	Nothing	O	300ml coffee	Relaxed, no needed to

					focus
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Appendix 11. Sleep Journal: Participant F

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	4 hours	headache	X	X	<ul style="list-style-type: none"> - Super tired - Feel like falling down - Sleepy - My eyes hurts
Mar 10	6 hours	headache	X	X	<ul style="list-style-type: none"> - Felt tired in the morning - Still active - I wanna lay down
Mar 11	7 hours	headache		X	<ul style="list-style-type: none"> - Normal - I am always sleepy for reason despite the number of hours I get
Mar 12	10 hours	I fell down	X	X	<ul style="list-style-type: none"> - Still sleepy - Eyes hurts
Mar 13	2 hours	My eyes hurts	X	X	<ul style="list-style-type: none"> - I wanna lay down - My head is heavy and it feels like someone is squishing my head - I was okay when I was taking the test, but I am extremely tired after
Mar 14	3 hours	Headache	X	X	<ul style="list-style-type: none"> - I want coffee - I want to sleep
Mar 15	2 hours	Headache	X	X	<ul style="list-style-type: none"> - I am not okay - My eyes hurts
Mar 16	7 hours	Headache	X	X	<ul style="list-style-type: none"> - I am more sleepy than

					usual - I want to sleep
Mar 17	3 hours	No symptoms	O	Starbucks tall size	- I feel normal - It felt like someone was dragging me afterschool, because I was slightly tired
Mar 18	4 hours	No symptoms	X	X	- I feel normal - It feels like someone is squeezing my head
Mar 19	5 hours	No symptoms	X	X	- I was able to concentrate at school
Mar 20	7 hours	Headache	X	X	-
Mar 21	3 hours	Headache	X	X	- My head hurts a lot. It feels like someone is squeezing my brain - I want to sleep
Mar 22	7 hours	Headache	X	X	-
Mar 23	9 hours	Headache	X	X	- I took a nap for 2 hours again

Appendix 12. Sleep Journal: Participant G

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	6h 15mins	Tiredness	X		Tired and sleepy
Mar 10	6h	Tiredness	X		Tired and sleepy
Mar 11	7h 30mins		X		Relaxed
Mar 12	9h	Anxious	O	1 cup mcafee	Relaxed
Mar 13	5h	Tiredness	X		Sleepy
Mar 14	5h 30mins	Tiredness	X		Sleepy
Mar 15	6h	Tiredness	X		Sleepy

Mar 16	5h	Tiredness	X		A little sleepy
Mar 17	6h	Tiredness	X		A little sleepy
Mar 18	6h 30mins		X		Okay
Mar 19	10h		X		Relaxed
Mar 20	9h 30mins		X		Relaxed
Mar 21	5h 30mins		X		Okay
Mar 22	4h 30mins		X		Sleepy
Mar 23	7h		O	Half cup latte	Okay

Appendix 13. Sleep Journal: Participant H

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	6		X		Tired not much energy.
Mar 10	7		x		More energy
Mar 11	6		o	One cup or less	Same tired burnt out from the whole week
Mar 12	6		x		Got used to sleep schedule/not even sleep
Mar 13	8		x		Awake and energetic
Mar 14	6		x		Trouble waking up/tired
Mar 15	5		x		
Mar 16	6		x		
Mar 17	4		x		
Mar 18	7		x		
Mar 19	6		x		Used to waking up early for school

Mar 20	5				
Mar 21	6				
Mar 22	1		x		Slept at 11 and woke up at 12
Mar 23	5		x		

Appendix 14. Sleep Journal: Participant I

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	8		X		Dizzy and tired, can function as usual but feels a bit uncomfortable
Mar 10	9		X		Refreshed, enough to go through the day up until 9pm
Mar 11	6		X		Occasionally tired throughout the day and minimum focus
Mar 12	7		O	2 glasses on the afternoon with 8:2 milk to coffee ratio	Woke up with minor headache, easily worn out in the afternoon
Mar 13	4		X		Can function throughout the day, hard to sleep at night
Mar 14	4		X		Headaches throughout the day
Mar 15	5		X		Woke up with headaches, easily worn out throughout the day
Mar 16	8		X		Hard to focus on schoolwork, ends up falling asleep right

					away after evening shower
Mar 17	9		X		Feels tired throughout the day
Mar 18	9		X		Sleep routine much better, can wake up normally and feels great throughout the day
Mar 19	7		X		Minor headaches in the morning
Mar 20	8		X		Headaches throughout the day
Mar 21	9		X		Hard to sleep at night, but feels great throughout the day
Mar 22	6		X		Headaches on one part of the head from morning to afternoon, more relaxed in the evening after exercise
Mar 23	6		O	1 glass of milk coffee with less coffee	Tired throughout the day but hard to sleep at night

Appendix 15. Sleep Journal: Participant J

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	5 hrs (+ 3 hrs nap)		O	1 shot	fatigued and lazy
Mar 10	7 hrs (+2 hrs nap)		X		sleepy and fatigued
Mar 11	6 hrs		O	1 shot	awake and a little hyper
Mar 12	6 hrs (+ 4 hrs		X		somewhat drowsy

	nap)				
Mar 13	3 hrs (+2 hrs nap in the morning)		O	1 shot	tired and sleepy
Mar 14	7 hrs	headache dizziness	X		sleepy and fatigued
Mar 15	6 hrs		X		very sleepy and lethargic
Mar 16	5 hrs		X		sleepy and tired
Mar 17	6 hrs		X		feeling lazy and lethargic
Mar 18	4 hrs		X		sleepy and fatigued
Mar 19	9 hrs (including naps)		X		tired and fatigued (too much sleep compared to my usual sleep hrs)
Mar 20	8 hrs		O	1 shot	pretty energetic and awake
Mar 21	8 hrs		O	1 shot	tired and wanting to sleep more in the morning; but when out of bed, energetic
Mar 22	7 hrs		O	1 shot	tired from waking up in the middle of the night; but energetic overall
Mar 23	7.5 hrs		O	1 shot	awake and alert

Appendix 16. Sleep Journal: Participant K

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	7 hours		O	2 shots of espresso	Tired
Mar 10	9 hours		X		Tired

Mar 11	7 hours		X		Energetic
Mar 12	9 hours		X		Energetic
Mar 13	7 hours		O	2 shots of espresso	Tired
Mar 14	5		X		Tired
Mar 15	4		X		Tired
Mar 16	2		X		Tired
Mar 17	3		X		Tired
Mar 18	5		X		Sleepy and I grew a pimple because I didn't sleep much
Mar 19	4		X		Tired
Mar 20	3		X		Really sleepy
Mar 21	7		X		Energetic
Mar 22	2		X		I have a headache
Mar 23	3		X		I have a headache

Appendix 17. Sleep Journal: Participant L

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	6		X		Very tired.
Mar 10	2		X		Do not feel tired or drowsy but do feel lightheaded.
Mar 11	4		X		Clear Mind
Mar 12	7		X		A little bit tired
Mar 13	7		X		Clear mind
Mar 14	4		X		Tired

Mar 15	5.5		X		Very tired
Mar 16	4		X		Had difficulties staying focused for a few hours.
Mar 17	5		X		Very tired
Mar 18	6		X		A little bit tired
Mar 19	8		X		Didn't have school because it's a saturday but had a clear mind the entire day.
Mar 20	7		X		Felt energetic because I had a great quality of sleep for 3 days in a row.
Mar 21	5		X		A little bit drowsy for the first 2 hours after waking up but was generally
Mar 22	6		X		Clear mind
Mar 23	6		X		Clear mind

Appendix 18. Sleep Journal: Participant M

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	4:00 hrs 2:30 - 6:30	Mood fluctuation	X		Felt sleepy after school. Moderate attention in class. I learned about electron configuration in school.
Mar 10	2:00 - 6:30 4:30 hrs	Mood fluctuation	O	2 cups	Not tired. But day dream frequently
Mar 11	4:00-6:30	Mood fluctuation	O	5 cups	Friday APWH Unit 5 Examination

	2:30 hrs				Sleepy Loud heart beats Nausea
Mar 12	1:30 - 7:30 6hrs	X	X		Get angry easy on small things
Mar 13	11:30 - 6:30 7 hrs	Unmotivated	X		Tired all day. Lack of focus Seek pleasure excessively
Mar 14	1:30-6:30 5hrs	Procrastination	X		Stress eating.
Mar 15	2:30-6:30	Procrastination Could not get things done	X		Ambivalence I self-rationalize myself for not studying hard
Mar 16	1:30-7:00	Procrastination	X		
Mar 17	1:00-6:30	Procrastination	X		X
Mar 18	1:00-6:30	Procrastination Anxiety	X		Tired the whole day, felt unmotivated to do things. Procrastinating so much I can't get things done.
Mar 19	2:30 - 6:15	Procrastination Self-hatred	X		Attached to phone
Mar 20	12:15-6:30	Procrastination	X		Mood fluctuations
Mar 21	1:14 - 9:35	Procrastination	X		Kinda depressed the whole day
Mar 22	1:30 - 6:30	Procrastination Mood fluctuation	X		I felt very unorganized
Mar 23	2:00-6:30	Procrastination	X		I couldn't get things done during the whole

		Mood fluctuation			break. So I had moments of feelings of self hatred. "Why can't i just get things done"
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Appendix 19. Sleep Journal: Participant N

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	4 hours (12:00am - 4:00am)	<ul style="list-style-type: none"> - Less physically active - Generally sleepy 	X	X	<ul style="list-style-type: none"> - Guilty; I accidentally fell asleep while completing a task. - Drained
Mar 10	3 hours (1 AM - 4AM)	<ul style="list-style-type: none"> - Slight migraine - Tired 	X	X	<ul style="list-style-type: none"> - Guilty; I accidentally fell asleep while completing a task. - Tired
Mar 11	6 hours (12-6)	<ul style="list-style-type: none"> - Tired - Neck pain 	X	X	<ul style="list-style-type: none"> - Guilty; I accidentally fell asleep while completing a task.
Mar 12	7 and a half hours (1 AM - 8:30 AM)	<ul style="list-style-type: none"> - Neck pain 	X	X	<ul style="list-style-type: none"> - Felt alright
Mar 13	3 hours (1 AM - 4AM)	<ul style="list-style-type: none"> - Neck pain 	X	X	<ul style="list-style-type: none"> - Guilty; I accidentally fell asleep while completing a task.
Mar 14	2 hours (5AM- 7 AM)	<ul style="list-style-type: none"> - Neck pain - Stressed 	X	X	<ul style="list-style-type: none"> - Tired

Mar 15	1 Hour (5-6)	- Neck pain	0	A cup of coffee	- Tired - Sleepy
Mar 16					
Mar 17					
Mar 18					
Mar 19					
Mar 20					
Mar 21					
Mar 22					
Mar 23					

Appendix 20. Sleep Journal: Participant O

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	7		x		Able to pay attention in class. Grasp concepts well. I was able to stay up the entire day for school.
Mar 10	8		x		Able to pay attention in class. Grasp concepts well. I was able to stay up the entire day for school.
Mar 11	9		x		Felt energized
Mar 12	5		x		Exhausted, and couldn't really concentrate on much things
Mar 13	6		x		Tired, but able to comprehend things
Mar 14	7		x		Energized

Mar 15	8		x		Energized
Mar 16	4		x		Exhausted, could not concentrate at all
Mar 17	8		x		Able to conentrate
Mar 18	5		x		Could not really remember what I leaned. Ideas weren't flowing.Exhausted
Mar 19	9		x		Super energized
Mar 20	8		x		Super energized
Mar 21	8		x		Super energized
Mar 22	5		x		Felt dizzy at times. Could not concentrate on a a lot fo things.
Mar 23	4		x		Had the worst concentration levels. Could not participate in any activites.

Appendix 21. Sleep Journal: Participant P

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	9 hrs	I have been waking up 2 or 3 times in the middle of the night not because of any symptoms (at least I hope not) because I occasionally turn on and off my AC due to my throat.	X		I woke up with slight regret of waking up and wanting to go back to sleep because of the hot-ness with the AC off mostly during my sleep, but after that I felt quite awake and ready for the day. During class I managed to pay attention and was ready to stick with what the teacher was saying for a long period

					of time.
Mar 10	8 hrs	Like the previous day, I woke up a couple times because of the AC, but this time was more intense, found harder to fall asleep most of the time.	X		I woke up a couple minutes before my alarm fully awake, naturally. During class I managed not to fall asleep of boredom, I was able to pay attention most of the time during class, enough to know what's going on in class.
Mar 11	7 hrs	I struggled to fall asleep the night before this day but woke up not feeling horrible.	O	I drank some Machiatto from Starbucks at around 4 pm but it did not effect my sleep, however.	I woke up once again a couple minutes before my alarm like I have weird powers. I had the capability of paying attention during class and to stay focused on work and assignments.
Mar 12	6 - 7 hrs	Like usually, no symptoms, only woke up a couple times covered in sweat to turn on the AC.	O	I drank a huge cup of ice cappuccino during mid day just to burn time, though it gave a small kick, but it wasn't for waking myself up from sleepiness.	I woke up fully at around 6:30 am but layed on my bed for a bit longer because I didn't felt like getting up, then got up at around 7.
Mar 13	7 hrs	Surprisingly, I woke up only when I had to pee and only 1 time when it was extremely hot to turn on the AC	X		I woke up fully at around 7 or 6 am, even though I slept at 1 am, but I managed to convince myself it was okay to be lazy and sleep some more.
Mar 14	5-6 hrs	Woke up couple times by just disturbances (AC, heat, cold, dog, etc)	X		I woke up with the feeling of less sleep (obviously). I was tired and found it hard to pay attention in class for 3 hrs straight, until I got fully awake.

Mar 15	8 hrs		X		I woke up with a good sleep and managed to pay attention for most of my classes.
Mar 16	9 hrs		X		I woke up with a decent amount of sleep, felt the energy to stay awake for most of the time, but sometimes I would still get very sleepy and struggle not to fall asleep.
Mar 17	8 hrs		X		I had the energy to get up immediately after my alarm but I didn't feel fully awake, sleepy most of the time. I was sleepy in most of my classes.
Mar 18	8½ hrs		X		I had a decent amount of sleep which enabled me to pay attention for most of the time the teacher is explaining something.
Mar 19	9 hrs		X		I woke up pretty lazy to get out of my bed so I stayed on my phone for a while. But the rest of the day I was okay, pretty awake and functional.
Mar 20	9 - 10 hrs		X		I woke up quite early automatically, since I realized it was a Sunday I went straight back to sleep and woke up at around 8 am. I wasn't too tired during the day, enough energy to get through the day.
Mar 21	7 hrs		X		I slept at around 9 or 10 pm then woke up at 4 am, surprisingly,

					without being very much sleepy or tired.
Mar 22	4 - 5 hrs		X		I still woke up hyped even though I slept for 4 to 5 hours to 2 am.
Mar 23	9 hrs	I slept nice and sound, woke up at certain times just to go pee and woken up one time when my boys were watching Netflix at 2 am.	X		I woke up pretty tired and lazy to get the day started. That day I had nothing planned but to check out the hotel with the boys at 11 am.

Appendix 22. Sleep Journal: Participant Q

Date	Hours slept (x hours)	Possible Symptoms	Caffeine (O or X)	For the previous column, if O, how much? beverage, size, times per day (leave blank if X in the previous column)	How you feel each day
Mar 9	6 and a half hours	Circadian rhythm disorders	0		I feel happy and energised but sometimes moody or annoyed easily.
Mar 10	6 hours	Circadian rhythm disorders	0		I am a bit tired and sleepy.
Mar 11	7 hours	Circadian rhythm disorders	0		I feel a bit more fresh today and happier.
Mar 12	7 and a half hours	Circadian rhythm disorders	0		I was a bit fresh and hyper in the morning.
Mar 13	8 hours	Circadian rhythm disorders	0		I was feeling happy and relaxed in the morning.
Mar 14	6 hours	Circadian	0		I was very tired this day

		rhythm disorders			and felt a bit sick.
Mar 15	7 hours	Circadian rhythm disorders	0		I felt fresh and calm
Mar 16	6 hours	Circadian rhythm disorders	0		I was slightly feeling low
Mar 17	5 hours	Circadian rhythm disorders	0		I was feeling sluggish and lazy
Mar 18	7 hours	Circadian rhythm disorders	0		I was happy and fresh
Mar 19	6 hours	Circadian rhythm disorders	0		I was excited and ready to start my day
Mar 20	6 hours	Circadian rhythm disorders	0		I was a bit tired and confused
Mar 21	7 hours	Circadian rhythm disorders	0		I was happy and fresh
Mar 22	8 hours	Circadian rhythm disorders	0		I felt happy and well fresh
Mar 23	7 and a half hours	Circadian rhythm disorders	0		I woke up feeling energised