Concordia University
Engineering and Computer Science

ENGR 371: Probability and Statistics for Engineers

The Relationship Between Caffeine and Sleep

Professor: Dr. Ivan Kantor

Ahmad Obeid
Hossam Khalifa
Matteo De Luca
Rim Echahbi

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Concordia University

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Introduction

Caffeine is a very popular substance for busy individuals.. It has many stimulative effects for the nervous system, brain, muscles and more [1]. Thus, young adults are often subject to drinking caffeine to feel as productive as possible during the day. Consequently, it can be dangerous due to the elevated blood pressure, heart stimulation and can lead to addictions. By using statistical methods, and by gathering data, this study plans to find a relation between caffeine consumption and sleep patterns. This will be done through both graphical interpretations and numerical calculations.

Hypothesis

The hypothesis that will be focused on is that there is a relation between caffeine intake and sleep. The more caffeine being consumed by young adults results in less sleep. This hypothesis will be tested by calculating the average hours of sleep of both people that consume less than one caffeinated drink to those that consume one drink or more. This hypothesis will be presented in the following where μ_1 is the average number of hours of sleep with less than one caffeinated drink and μ_2 is the average amount of sleep with one or more caffeinated drinks. This gives us the following:

H_0: $\mu_1=\mu_2$

H_1: $\mu_1\neq\mu_2$

For the purpose of our experiment our μ_2 will be the average number of hours of sleep by those who drink less than one caffeinated drink.

This hypothesis allows us to find if there is a relation between caffeinated drinks and sleep. A two-tailed test will be performed since we are not concerned whether more or less sleep will be achieved with caffeine. In addition to seeing the relevancy of caffeine to sleep, additional data is found to see the effect that the time of consumption will have as well as the occupation commitment and/or school commitment of each person.

Procedure

The data for this project was gathered through multiple questions surveys, conducted both in-person on the school premises, at the libraries, to try and get information from every different program, as well as through online surveys advertised through Concordia groups. Online surveyors were the bulk of our population.

Given the fact that there are currently around 10,000 full-time students enrolled in any given term, our sample size goal was to get at least 50 different people to answer.

The specific questions that were asked were the following:

1. Program of study (Only faculty was considered for simplification)
    - Faculty of Arts and Science
    - Faculty of Engineering and Computer Science
    - Faculty of Fine Arts
    - John Molson School of Business
2. Full-time or part-time study / full time or part time work
3. Number of hours slept of average
4. Number of caffeinated drinks taken a day
5. Time of drinking caffeinated drinks

Enough sample size was acquired after 2 weeks of surveying.

Collected data

#	Faculty	# of Caffienated Drinks	# of sleep hours	Full time/part time worker?	Full time/part time student?
1	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Not a worker	Full-time student
2	Gina Cody School of Engineering and Computer Science	4	6-7 hours	Full time worker	Full time student
3	Gina Cody School of Engineering and Computer Science	2	8+ hours	Not a worker	Full time student
4	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Part time worker	Full time student
5	Gina Cody School of Engineering and Computer Science	3	4-5 hours	Part time worker	Full time student
6	Gina Cody School of Engineering and Computer Science	3	4-5 hours	Not a worker	Full time student
7	Gina Cody School of Engineering and Computer Science	2	6-7 hours	Not a worker	Full time student
8	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Part time worker	Full time student
9	Gina Cody School of Engineering and Computer Science	4	6-7 hours	Full time woker	Not a student currently
10	Gina Cody School of Engineering and Computer Science	7+	8+ hours	Not a worker	Full time student
11	Gina Cody School of Engineering and Computer Science	1	6-7 hours	Not a worker	Full time student
12	Gina Cody School of Engineering and Computer Science	3	6-7 hours	Not a worker	Full time student
13	Gina Cody School of Engineering and Computer Science	5	6-7 hours	Not a worker	Full time student
14	Gina Cody School of Engineering and Computer Science	3	4-5 hours	Not a worker	Full time student
15	Gina Cody School of Engineering and Computer Science	1	4-5 hours	Not a worker	Full time student
16	Gina Cody School of Engineering and Computer Science	0	0-1 hours	Not a worker	Full time student
17	Gina Cody School of Engineering and Computer Science	7+	0-1 hours	Not a worker	Full time student
18	Gina Cody School of Engineering and Computer Science	2	4-5 hours	Full time worker	Part time student
19	Gina Cody School of Engineering and Computer Science	0	8+ hours	Not a worker	Full time student
20	Gina Cody School of Engineering and Computer Science	1	8+ hours	Not a worker	Full time student
21	Gina Cody School of Engineering and Computer Science	1	6-7 hours	Not a worker	Full time student
22	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Not a worker	Full time student
23	Gina Cody School of Engineering and Computer Science	0	2-3 hours	Not a worker	Part time student
24	Gina Cody School of Engineering and Computer Science	3	8+ hours	Not a worker	Full time student
25	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Not a worker	Full time student
26	Gina Cody School of Engineering and Computer Science	0	6-7 hours	Not a worker	Full time student
27	Gina Cody School of Engineering and Computer Science	3	4-5 hours	Not a worker	Full time student
28	Gina Cody School of Engineering and Computer Science	2	6-7 hours	Not a worker	Full time student

29	**Gina Cody School of Engineering and Computer Science**	0	8+ hours	Not a worker	Full time student
30	**Gina Cody School of Engineering and Computer Science**	0	6-7 hours	Full time worker	Full time student
31	**Gina Cody School of Engineering and Computer Science**	2	6-7 hours	Not a worker	Full time student
32	**Faculty of fine arts**	1	6-7 hours	Not a worker	Full time student
33	**Faculty of fine arts**	1	6-7 hours	Not a worker	Full time student
34	**Faculty of Arts and Science**	1	6-7 hours	Not a worker	Full time student
35	**Faculty of Arts and Science**	1	6-7 hours	Not a worker	Full time student
36	**Faculty of Arts and Science**	2	8+ hours	Not a worker	Full time student
37	**Faculty of Arts and Science**	0	6-7 hours	Full time worker	Not a student currently
38	**Faculty of Arts and Science**	2	6-7 hours	Part time worker	Full time student
39	**Faculty of Arts and Science**	3	8+ hours	Not a worker	Full time student
40	**Faculty of Arts and Science**	1	4-5 hours	Not a worker	Full time student
41	**Faculty of Arts and Science**	1	8+ hours	Not a worker	Full time student
42	**Faculty of Arts and Science**	2	6-7 hours	Not a worker	Full time student
43	**Faculty of Arts and Science**	1	8+ hours	Not a worker	Full time student
44	**Faculty of Arts and Science**	2	8+ hours	Not a worker	Full time student
45	**Faculty of Arts and Science**	0	8+ hours	Part time worker	Full time student
46	**Faculty of Arts and Science**	1	6-7 hours	Full time worker	Not a student currently
47	**Faculty of Arts and Science**	0	6-7 hours	Full time worker	Not a student currently
48	**John Molson school of business**	0	8+ hours	Not a worker	Full time student
49	**John Molson school of business**	2	6-7 hours	Not a worker	Full time student
50	**John Molson school of business**	0	8+ hours	Not a worker	Full time student
51	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
52	**John Molson school of business**	0	4-5 hours	Not a worker	Full time student
53	**John Molson school of business**	2	8+ hours	Not a worker	Full time student
54	**John Molson school of business**	2	6-7 hours	Not a worker	Full time student
55	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
56	**John Molson school of business**	0	6-7 hours	Part time worker	Full time student
57	**John Molson school of business**	0	6-7 hours	Not a worker	Full time student
58	**John Molson school of business**	2	4-5 hours	Not a worker	Full time student
59	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
60	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
61	**John Molson school of business**	0	8+ hours	Not a worker	Full time student
62	**John Molson school of business**	4	4-5 hours	part time worker	Full time student
63	**John Molson school of business**	0	8+ hours	Not a worker	Full time student
64	**John Molson school of business**	0	8+ hours	Not a worker	Full time student
65	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
66	**John Molson school of business**	1	6-7 hours	Not a worker	Full time student
67	**John Molson school of business**	1	4-5 hours	Not a worker	Full time student

Observations

Gathering 67 responses, we needed to know if the responders are students or workers to be able to make a more accurate analysis. With the last question, we confirm that most of them are full-time students. There are some exceptions such as:

A) 3 part time students
B) 4 full time workers
C) 1 part-time student and full time worker
D) 5 full-time students as well as part-time workers
E) 3 full-time students as well as full-time workers

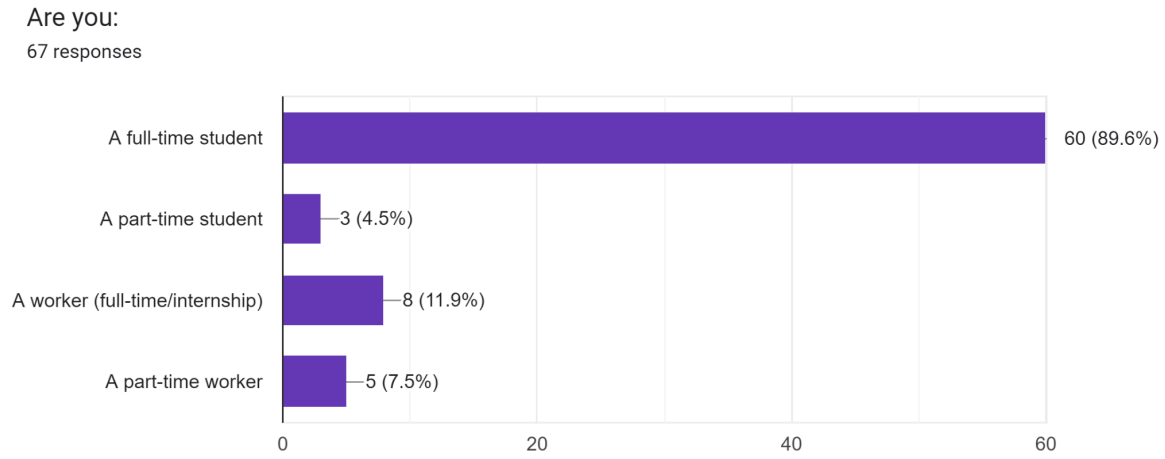


Figure 1: Data on type of person to fill the form

Then we immediately notice that what the team discussed, before sending the google form, is true. There is a majority of people who do not drink caffeine, while on the other hand, the people who do usually drink 1 or 2 caffeine drinks only (a majority of nearly 50%).

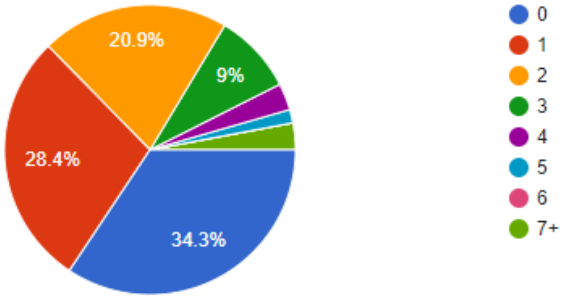


Figure 2 : Data on the number of caffeinated drinks per person

When we proceed to the next question, we notice another observation regarding the most likely time to drink caffeine. Other than the percentage of people who do not drink caffeine, we see that the most time people drink caffeine before the afternoon, which makes sense since the majority of the responders are students who like to delay their classes in order to not need to wake up early. Also notice how the percentages of “0” caffeine people and “I don't drink” people in figures 2 and 3 don't add up, this could be due to responder misunderstanding and selecting a time if they were to drink.

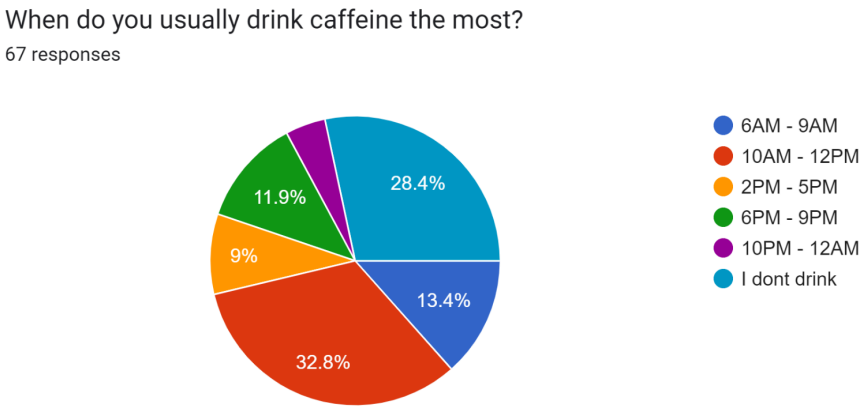


Figure 3 : Data on the time people drink caffeine

With all these details, we asked the average time they sleep whether they drink caffeine or not. Here we start theorizing about our hypothesis. By taking in all the data and comparing our hypothesis with our calculations we can conclude whether caffeine has an impact on sleep that can't be ignored.

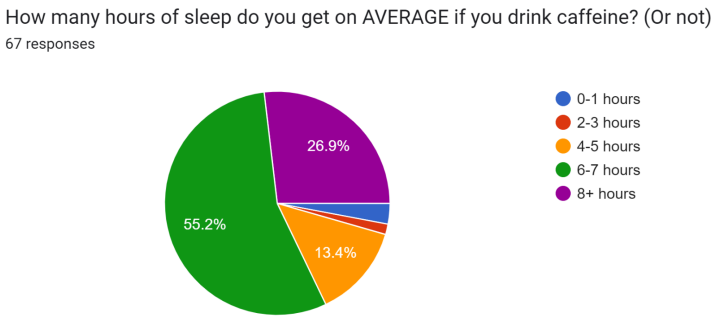


Figure 4 : Data on the average time people sleep per day

The results from the survey showed (as was expected due to the large population of gina cody students in the online groups where the forms were shared) that the majority of our population belonged to the gina cody school of engineering. The second largest group were from the john molson school of business, followed closely by the faculty of arts and science, leaving the faculty of fine arts as the smallest group (with only 2 surveyed).

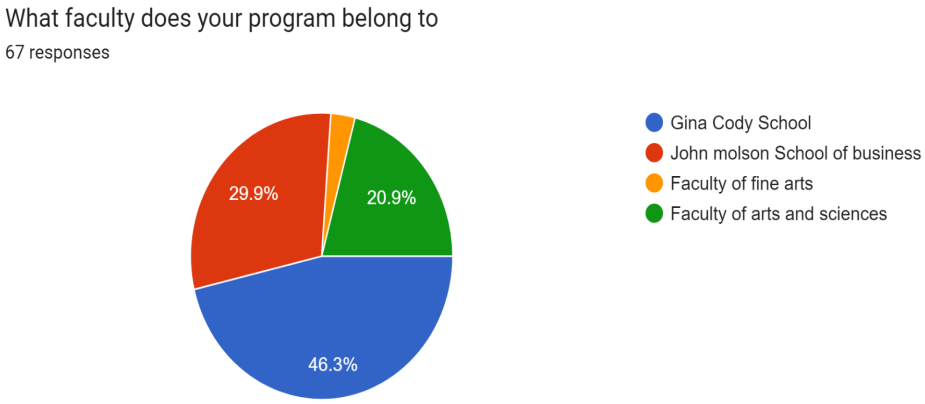


Figure 5 : Data on what faculty are people programs in

Analysis

(No software was used in the calculations)

Based on the data collected, illustrated in Table I, and Figure 1 to Figure 5, the sample mean, sample median, sample mode, sample variance, and sample standard deviation were calculated. These values can be found in the tables below.

The data was calculated multiple times for multiple different groups. Calculations for groups based on the faculty and others based on the occupation were made. Different data was also collected for "hours of sleep" and for "number of caffeinated drinks taken".

Hours of sleep

Parameters	Mean	Median	Mode	Variance	Standard deviation
Gina Cody School of Engineering and Computer Science (31)	5.89 hours	6.5 hours	6-7 hours	3.67	1.92
Faculty of fine arts (2)	6.5 hours	6.5 hours	6-7 hours	0	0
Faculty of arts and science (14)	7 hours	6.5 hours	6-7 hours	1	1
John Molson school of business (20)	6.55 hours	6.5 hours	6-7 hours	1.4725	1.213
Combined (67)	6.337 hours	6.5 hours	6-7 hours	2.51	1.58

Table 1 : Values of Mean, Variance, and Standard Deviation By Faculty

Hours of sleep

Parameters	Mean	Median	Mode	Variance	Standard deviation
Full time worker + full time student (3)	5.83 hours	6-7 hours	6-7 hours	0.89	0.943
Full time worker + part time student (1)	4.5 hours	4.5 hours	4-5 hours	--------	--------
Part time worker + full time student (5)	6.4 hours	6-7 hours	6-7 hours	1.24	1.114
Only a worker (4)	6-7 hours	6-7 hours	6-7 hours	0	0
Only a student (52)	6.35 hours	6-7 hours	6-7 hours	2.98	1.725

Table 2 : Mean, Variance, and Standard Deviation By Person Type

Caffeinated drinks drank

Parameters	Mean	Median	Mode	Variance	Standard deviation
Gina Cody School of Engineering and Computer Science (31)	1.9 drinks	2 drinks	0 drinks	3.89	1.97
Faculty of fine arts (2)	1 drink	1 drink	1 drink	0	0
Faculty of arts and science (14)	1.214 drinks	1 drink	1 drink	0.74	0.86
John Molson school of business (20)	0.95 drinks	1 drink	0 drinks	1.0475	1.02
Combined (67)	1.45 drinks	1 drink	0 drinks	2.456	1.57

Table 3 : Values of Mean, Variance, and Standard Deviation By Faculty

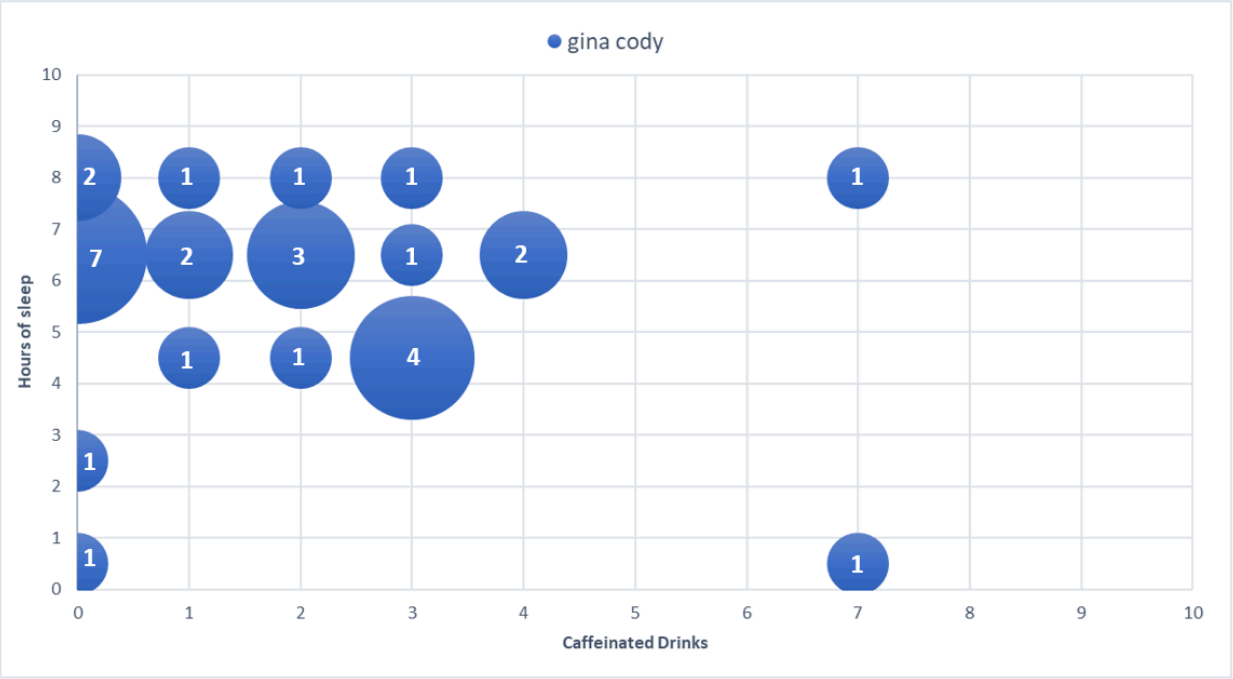
Caffeinated drinks drank

Parameters	Mean	Median	Mode	Variance	Standard deviation
Full time worker + full time student (3)	2.66 drinks	4 drinks	4 drinks	3.5556	1.89
Full time worker + part time student (1)	2 drinks	2 drinks	2 drinks	----------	----------
Part time worker + full time student (5)	0.6 drinks	0 drinks	0 drinks	1.44	1.2
Only a worker (4)	1.25 drinks	0.5 drinks	0 drinks	2.6875	1.64
Only a student (54)	1.5 drinks	1 drink	1 drink	2.32	1.52

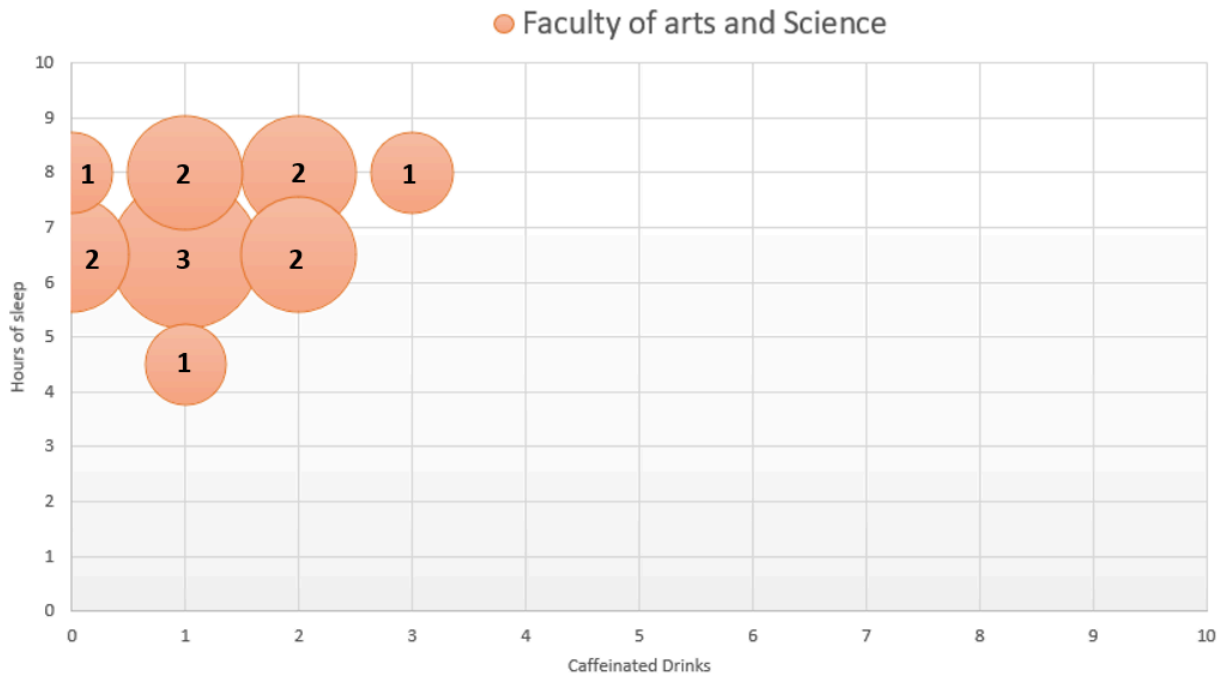
Table 4 : Values of Mean, Variance, and Standard Deviation By Faculty

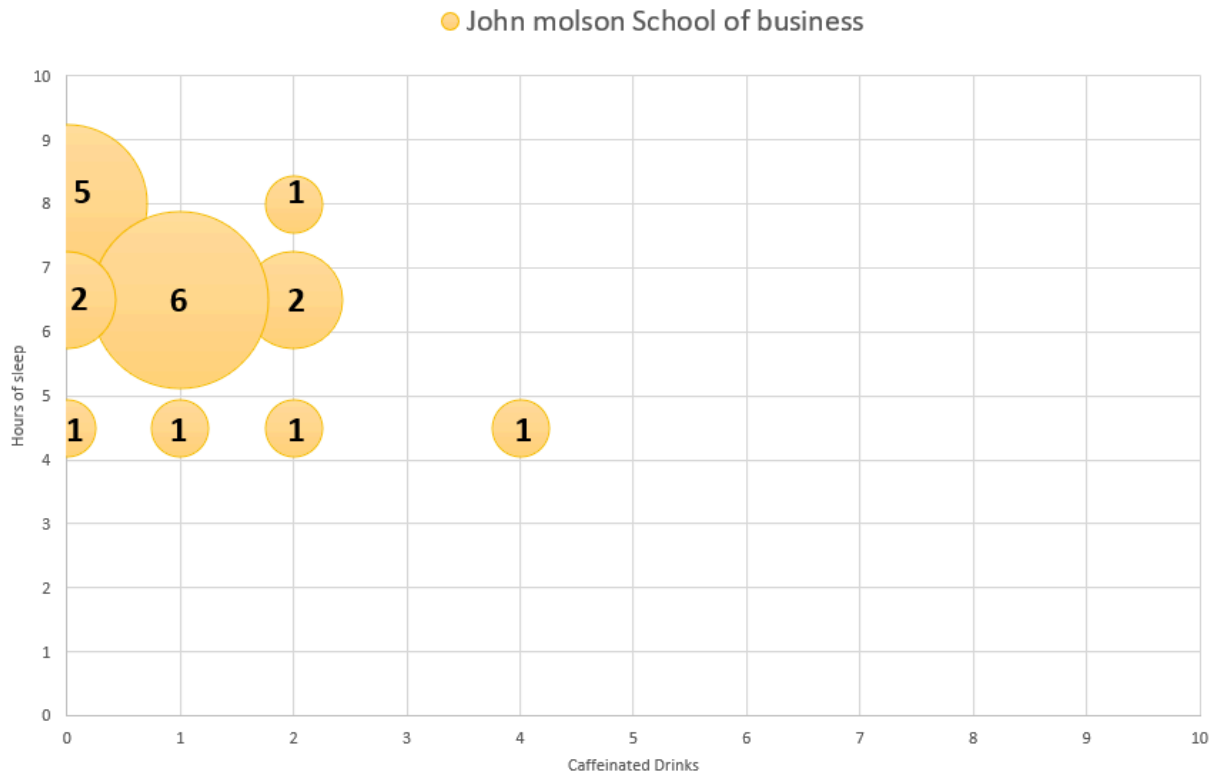
Charts 1 : Distribution of people (in different faculties) by their Hours Slept and Caffeinated Drinks Taken

The number on the circles (shows in their size too) is the number of people






Faculty of arts and Science
Hours of sleep
Caffeinated Drinks
0 1 2 3 4 5 6 7 8 9 10
1 2 2 1
2 3 2
1


John molson School of business
Hours of sleep
Caffeinated Drinks
0 1 2 3 4 5 6 7 8 9 10
5 1
2 6 2
1 1 1 1

Hypothesis Testing

Using a two tail, normal distribution with a 95% confidence, the hypothesis can be tested.

$\mu_1 = \bar{x} = 7.55\ hours\ at\ X\ (\#of\ coffees\ drank) < 1$

$\mu_2 = 6.2\ hours\ at\ X'$

1. Parameter of Interest: μ, $\sigma_2 = 3.44$
2. Null Hypothesis: H_0: $\mu_1 = \mu_2$
3. Alternative Hypothesis: H_1: $\mu_1 \neq \mu_2$
4. Test Statistic: $Z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$
5. Rejection criteria: P-value< 0.05
6. Computations:

   $Z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \frac{7.55 - 6.2}{3.44/\sqrt{47}} = 2.69$

   $\boldsymbol{\Phi}(Z) = 0.99647$

   $P - Value = 2[1 - 0.99647] = 0.00706 < 0.05$
7. Conclusion: reject H_0 and accept H_1

Conclusion

In summary, our investigation into the effects of coffee on young individuals' sleep patterns has uncovered interesting findings, with strong data contradicting our preliminary hypotheses. Remarkably, Furthermore, our comprehensive investigation did not only confirm our major hypothesis, but also offered insight into a more complex relationship between coffee intake, length of sleep, and the impact of academic faculty.

The main hypothesis of the theory was to establish a relationship between caffeine and sleep. In particular, our hypothesis was that young persons who consume more coffee would sleep fewer hours. Based on a complete statistical analysis that involved means, medians and modes among others, it was clear that this aspect had been addressed adequately hence confirming our central hypothesis.

An analysis of our preliminary hypotheses provided additional insight on our findings corresponding with the preliminary hypotheses. The use of statistical measures such as means, medians and modes among others helped to simplify the assessment proving the main hypothesis valid regarding coffee consumption and sleep association. Notably,we observed a distinct pattern in the sleeping habit of Gina Cody Faculty. Although Gina Cody had the lowest mean sleep duration across the faculties, her median and mode were different from each other. This finding implied the existence of individuals who routinely slept less than the norm, which added important context to the wider implications of our study.

Furthermore, our observations underscore a significant correlation between amplified intake of caffeine especially within Gina Cody Faculty and the consistent decrease in average sleep duration among young adults. We can make this claim based on their above-average mean and median in comparison to other faculties or the population as a whole.

Consequently, we may accept the alternative hypothesis ($H1: \mu1 \neq \mu2$) with confidence that the null hypothesis ($H0: \mu1 = \mu2$) is false. This finding demonstrates

how meaningful our work is since it supports not only the established relationship between caffeine and sleep but also shows how academic faculties come into play.

This information will hopefully lead to further investigation into lifestyle factors, which will in turn help young people develop strategies so as to find a good balance between caffeine intake for studying purposes and getting enough sleep. Lastly, the variety of our research implies possibilities for future study, further understanding of young adults' complicated relation with coffee, rest, and other contextual factors in their lives.

Comments

The data gathered was done on campus and through personal relations to the group members. The data was gathered from young adults. This data proved to not be completely random as there are a lot of data points that came from the Gina Cody School of Engineering. This data showed that these students tend to get less sleep, and consume more coffee. This could be a reason for the data to be less random than wanted. It created a larger batch of similar data that tends towards a certain hypothesis. In comparing other faculties and getting a good general dispersion of students, the variable would be more random.

In order to make it a random sample, we should have gathered an equal number of surveyors from each faculty. A larger number of total surveyors would also have helped reduce the margin of error and the effects any outliers might have had on the true information. 50 people from each faculty would have achieved both goals. This would create less localized data and more global information from a variety of different students.

Our hypothesis gave conclusive data. The reason to change anything about it would be if a more accurate result was needed. By specifying a one tail test or by adding more parameters, a more detailed statistical evaluation could be conducted.

We definitely believe that our results can be extrapolated to draw more conclusions as there is a much bigger population compared to just students in just a city, for example. We can use the student caffeine data to deduce at least some reasonings with a background research. There can be some limitations such as cultural or generational differences, however as long as the environment is similar to the one conducted for this research, such as company workplaces or school campuses the results should be accurate enough.

It is important to note that in this research, all the calculations and analysis were manually done without the use of any software.

References

[1]“CAFFEINE: Overview, Uses, Side Effects, Precautions, Interactions, Dosing and Reviews.” https://www.webmd.com/vitamins/ai/ingredientmono-979/caffeine

[2]D. C. Montgomery and G. C. Runger, “Applied Statistics and Probability for Engineers, 7th Ed.,” *Wiley*, 2018.