

Science Fair Logbook

By: Hania Akbar 8A

Calgary Islamic School Akram Jomaa Campus

Date:	What Did I Do Today?	Notes (If Necessary):
December 2 2024	→ I made a Google Doc	→ My science teacher assigned us this project
December 3 2024	→ I decided to do a research project instead of experiment → I Jotted down topic ideas and questions.	→ While experiment projects are funner, i want to try something new as i did an experiment project in Grade 6 (However I might change my mind)
December 4 2024	→ I Decided a topic that interested me → I Got it approved by my science teacher	→ Decided on "Kidney stones" → Decided on "Can the consumption of caffeine or addictive drugs affect kidney stone function?"
December 5 2024	→ I constructed a template of which questions to research	
December 6 2024	→ I designed a sketch of a Kidney Stone Model	→ My science teacher suggested that I make a urinary tract model
December 7 2024	→ I am Working on the sketch	
December 8 2024	→ I completed the sketch → I got the materials approved by my mom	
December 9 2024	→ I am taking a break	→ I have so many other assignments to complete!
December 10 2024		
December 11 2024		
December 12 2024		
December 13 2024		
December 14 2024	→ I began writing my hypothesis	
December 15 2024	→ I got my hypothesis approved by my science teacher	

December 16 2024	→ I began writing my variables	→ I am having some trouble thinking of variables,I will come back to this later
December 17 2024	→ I jotted down the headings to my research	
December 18 2024	→ I started writing: What is a Kidney Stone?	
December 19 2024	→ I am taking a break	→ I had a field trip today so I was too tired to continue writing
December 20 2024	→ I finished writing: What is a Kidney Stone? → I finished writing: How are Kidney stones Formed?	→ Winter break started, I have lots of time now.
December 21 2024	→ I started writing: How do Kidney Stones Affect Kidney stone function?	→ I want to cover many topics in this section. This might take me a while.
December 22 2024	→ Writing: How do Kidney Stones Affect Kidney stone function?	
December 23 2024	→ Writing: How do Kidney Stones Affect Kidney stone function?	
December 24 2024	→ Writing: How do Kidney Stones Affect Kidney stone function? → I made a list of inquiries to ask a professional and sent it to Dr. Maham Zehra.	
December 25 2024	→ Writing: How do Kidney Stones Affect Kidney stone function?	
December 26 2024	→ Writing: How do Kidney Stones Affect Kidney stone function?	
December 27 2024	→ Finished Writing: How do Kidney Stones Affect Kidney stone function? → I started writing: What is	

	the relationship between caffeine and kidney stones?	
December 28 2024	→ I finished writing: What is the relationship between caffeine and kidney stones?	
December 29 2024	→ I finished writing: What is the relationship between gateway drugs and kidney stones? → I started writing: How are kidney stones diagnosed?	→ Dr. Maham Zehra sent me her report
December 30 2024	→ I had a verbal interview with Akbar Rais (an experienced individual) by asking him about his kidney stone experience. → I copied all of his responses onto a Google Doc.	
December 31 2024	→ I am changing my question slightly.	→ I think my original question was too basic. I changed it to: What biological, diagnostic, and lifestyle factors link caffeine and gateway drug use to the development of kidney stones?
January 1 2025	→ I am taking a break	→ I have to go somewhere for the next 3 days!
January 2 2025		→ I bought all of the materials I need for my project
January 3 2025		
January 4 2025	→ I finished writing: How are kidney stones diagnosed? → I started writing: What Procedures Are Used to Remove Kidney Stones?	
January 5 2025	→ I finished writing: What	→ I decided to change my

	Procedures Are Used to Remove Kidney Stones?	question back as I am running out of time and that topic is too broad.
January 6 2025	→ I finished writing: What symptoms do kidney stones cause? → I finished writing: What medications are used to treat kidney stones?	
January 7 2025	→ I chose a google slides template for my presentation using SlidesGo .	
January 8 2025		→ I got lazy and forgot.
January 9 2025	→ I started copying everything onto Google Slides	→ This is taking longer than I expected.
January 10 2025	→ I continued copying everything onto Google Slides	
January 11 2025	→ I continued copying everything onto Google Slides	
January 12 2025	→ I continued copying everything onto Google Slides	
January 13 2025	→ I began adding pictures → I decided what type of graphs to make	
January 14 2025	→ I added all of the pictures	→ I don't think I will have enough time to complete the model. I will make it if I get nominated into the school science fair.
January 15 2025	→ I finished writing: Conclusion, Acknowledgements, Sources of Error & Application → I finished making all of the graphs	

January 16 2025	→ I am taking a break	→ I had other assignments pending.
January 17 2025	→ I am taking a break	→ I had other assignments pending.
January 18 2025	→ I started making a video for peer evaluation.	→ My teacher told us that we need to make a video for peer evaluation → This is going to take me a while. → My recordings aren't working too well.
January 19 2025	→ I Added a few more recordings	
January 20 2025	→ I am taking a break	→ This has stressed me out so much.
January 21 2025	→ I Started editing	
January 22 2025	→ I Finished editing → I am finalizing my work	
January 23 2025	→ I submitted everything	
January 28 2025	→ I made flashcards for my presentation → I made more graphs → I bought the logbook binder today	→ I got nominated for the School science fair! → It will be on the 30th, I have no time to make the model however I will make use of what I have
January 29 2025	→ I practiced my presentation	
January 30 2025	→ I decided on what extra topics to add, I decided on: 1. What is Caffeine? 2. How does Caffeine affect the body? 3. What is the relationship between Caffeine & Kidney Stones? 4. How does Caffeine increase Calcium in the urine? 5. How does Caffeine increase the risk of Calcium Oxalate stones? 6. How does Caffeine	→ I had the school science fair today → I discussed my presentation to my substitute teacher, Ms. Harvey, who is genetically prone to kidney stones. She gave me some more information. → Both of my judges had advised me to increase my information for Caffeine and Addictive Drugs, so that is the plan. → Overall the presentations

	influence urine acidity or alkalinity? 7. How does urine acidity or alkalinity affect kidney stones? 8. Summary 9. What are gateway drugs? 10. How do gateway drugs affect kidney function? 11. Types added: Alcohol & Nicotine 12. Summary	went well → I am planning to give examples of different types of caffeine and their effects on kidney stone formation. However, I don't know which ones yet.
February 1 2025	→ I finished writing: What is caffeine? → I finished writing: How does caffeine affect the body? → I finished writing: How does Caffeine affect the body? → I finished writing: What is the relationship between Caffeine & Kidney Stones? → I finished writing: How does Caffeine increase Calcium in the urine? → I finished writing: How does Caffeine increase the risk of Calcium Oxalate stones?	→ I got nominated to go to the CYSF! → I am trying to finish these extra topics as soon as possible so that I can work on the platform and trifold. So I need to work at a quick pace.
February 2 2025	→ I finished writing: How does Caffeine influence urine acidity or alkalinity?	
February 3 2025	→ I finished writing: How does urine acidity or alkalinity affect kidney stone formation?	
February 4 2025	→ I finished writing: What is Substance Abuse?	
February 5 2025	→ I requested my science fair coordinator to accommodate me by	→ I am going on vacation for a family event so I need to receive the trifold early

	letting me collect my trifold before my vacation	
February 6 2025		→ I received the trifold.
February 7 2025	→ I am taking a break	→ Today is my flight!
February 8 2025	→ I am taking a break	
February 9 2025	→ I am taking a break	
February 10 2025	→ I started writing: What are Gateway Drugs?	→ I am quite busy on this trip so I will be working at a slower pace.
February 11 2025	→ Writing: What are Gateway Drugs?	
February 12 2025	→ I finished writing: What are Gateway Drugs?	
February 13 2025	→ I started writing: How do Gateway Drugs affect Kidney Function?	
February 14 2025	→ I finished writing: How do Gateway Drugs affect Kidney Function?	
February 15 2025	→ I am taking a break	→ I need to go somewhere
February 16 2025	→ I am taking a break	→ I need to go somewhere
February 17 2025	→ I decided the types of independent variables I am going to research. I decided on: ➤ Caffeine: Monster Energy Drinks, Nescafe Iced Tea & President's Choice Granola Bars ➤ Gateway Drugs: Alcohol & Nicotine ➤ Illicit Drugs: MDMA & Cocaine	
February 18 2025	→ I am taking a break	→ I have other engagements for these next few days.
February 19 2025	→ I am taking a break	

February 20 2025	→ I am taking a break	
February 21 2025	→ I am taking a break	
February 22 2025	→ I am taking a break	→ Today is my return flight!
February 23 2025	→ I am taking a break	
February 24 2025	→ I started copy and pasting my work onto the CYSF Platform	
February 25 2025	→ I started copy and pasting my work onto the CYSF Platform	
February 26 2025	→ I started copy and pasting my work onto the CYSF Platform	
February 27 2025	→ I finished writing: MDMA	
February 28 2025	→ I finished writing: Cocaine	
March 1 2025	→ I am taking a break	→ Today is the first day of our religious holiday, Ramadan, so I did not want to spend it working.
March 2 2025	→ I started writing: Alcohol	→ I will be working at a slower pace these next few days because of school assessments and religious engagements.
March 3 2025	→ Writing: Alcohol	
March 4 2025	→ I finished writing: Alcohol	
March 5 2025	→ I started writing: Nescafe Iced Coffee	
March 6 2025	→ I finished writing: Nescafe Iced Coffee	
March 7 2025	→ I started writing: Monster Energy Drinks	
March 8 2025	→ I finished writing: Monster Energy Drinks	
March 9 2025	→ I started Writing:	

	President's Choice Granola Bars	
March 10 2025	→ I finished Writing: President's Choice Granola Bars	
March 11 2025	→ I am working on the CYSF platform	
March 12 2025	→ I am working on the CYSF platform	
March 13 2025	→ I am working on the CYSF platform	
March 14 2025	→ I begun making more graphs	
March 15 2025	→ I am working on the graphs	
March 16 2025	→ I have started making the kidney model	
March 17 2025	→ I am finalizing my work	
March 18 2025	→ I am almost done	→ My main focus now is the trifold and the model.
March 19 2025	→ I am 90% done the CYSF platform	
March 20 2025	→ I finished everything	→ Spring break has also started so I will need to begin making the trifold.

Topic Selection

Topic Ideas:

- Bones In The Human Body (Fractures? X-Ray? Healing?)
- Robotic Hand
- ★ **Kidney Stones**
- Impact of Exercise on Heart Rate
- What is the Effect of Posture on the Spine?
- What Factors Affect DNA Replication?

Question Ideas:

- How do kidney stones grow overtime?
- How do kidney stones affect kidney function?
- Why are kidney stones more common in older people compared to younger people?
- ★ **How does the consumption of caffeine or addictive drugs impact kidney stone formation?**
- What biological, diagnostic, and lifestyle factors link caffeine and gateway drug use to the development of kidney stones?
- What chemical reactions occur when kidney stones form in the kidney?
- How does the body's immune system react to kidney stones?

Background Research

Hypothesis

If you consume large amounts of caffeine or addictive substances then you are more likely to develop kidney stones in your urinary tract because as a diuretic, chronic caffeine consumption can increase calcium excursion in the urine by as much as 77%. As for addictive substances,

Chronic consumption of substances can impair function in the liver, the heart and most importantly the kidneys by increasing waste excursion and potentially narrowing the blood vessels creating an environment for kidney stones to form.

Furthermore, in regards to my comparison between caffeinated goods such as Nescafe Iced

Coffee, Monster Energy drinks and President's Choice Granola Bars, I hypothesize that Monster Energy drinks will be the greatest risk factor for kidney stone formation due to its excessive amounts of sugar and caffeine additives as they may increase calcium excursion in the urine or make worse kidney impairments. And that President's Choice Granola Bars will be the lowest risk factor as they may be a good source of micronutrients and energy.

As for addictive substances I hypothesize that for the illicit substances (MDMA and Cocaine), Cocaine will be the greatest risk factor due to its link with bone resorption and other health disadvantages and for gateway substances (Alcohol and nicotine), Alcohol will be the greatest risk factor due to its impact on the liver and link with oxalate excursion.

And finally, I hypothesize that Addictive substances will have a slightly greater impact on kidney stone formation in comparison to caffeine because of their increasing health disadvantages and disliked demeanor of consumption by healthcare professionals for any age group. Additionally, I think Illicit drugs also have a greater impact on kidney stone formation rather than gateway drugs due to their more long lasting effects and health concerns.

What is a Kidney Stone?

Kidney stones, also known as **renal calculi** or **nephrolithiasis**, are hard, solid masses formed from clusters of tiny particles in urine. These stones can develop in one or both kidneys (**unilateral or bilateral**) and vary significantly in size, color, and texture. Typically yellow or brown, they can range from the size of a tiny pebble or a small pea to, in rare cases, as large as a golf ball. Depending on its environmental factors and conditions, kidney stones can have smooth surfaces or jagged edges. Furthermore, kidney stones typically form in the renal pelvis, a gland in the inner lining of the kidney, particularly at the point where urine transitions from the kidney tissue into the urinary collecting system. This area provides an environment where minerals and waste products in urine can crystallize and begin to accumulate, eventually forming stones.

How Are Kidney Stones Formed?

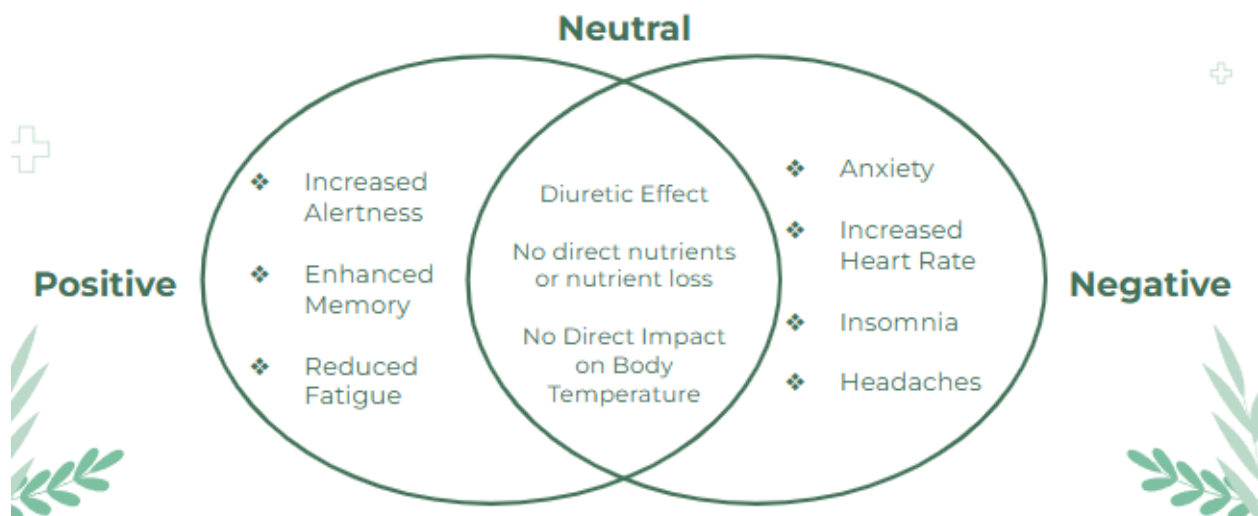
Formation of kidney stones begin from substances such as: **calcium**, **oxalate**, and **uric acid**, the key components of the urine in our body. However, these substances can become out of balance and can lead to **higher concentration** of solutes (such as calcium, oxalate, etc.) than there is solvent (water), creating a condition known as **supersaturation**. This **high concentration** allows the substances to crystallize, initiating a process known as **nucleation**, where dozens of crystal particles stick together to form a stone. Overtime, the crystal particles build up and grow into larger stones. Furthermore, kidney stones develop when the urine becomes **concentrated**, creating an environment where crystallization is more likely to occur. Kidney stones may cause discomfort or excruciating pain as they exit the interior surface of the kidney, move through the **ureter** and enter the urinary tract triggering pain due to pressure and tissue irritation.

What is the relationship between caffeine and kidney stones?

What is Caffeine?

Caffeine is a stimulant, meaning it can increase energy in the nervous system and in the brain by 10-50% (exact percentage depends on different factors). But whether that energy is increased in positive ways or negative ways may vary, as consuming caffeine in small amounts can help with refreshment and attentiveness while consuming larger doses can generate anxiety or insomnia. It is a common misconception that caffeine can only be found in coffee, however that is not actually the case. Caffeine can also be found in substances such as tea, cocoa, energy drinks, soft drinks and even energy bars.

How does Caffeine affect the body?



What is the relationship between caffeine and kidney disease?

Interesting enough, caffeine intake can actually reduce the odds of kidney diseases such as kidney stones by 40%. This is because, as a chemical, caffeine is a diuretic, meaning it increases the amount of urine your body produces, diluting the amount of stone producing minerals (calcium, oxalate, and uric acid). However, that increase of production can also increase the amount of urinary solutes. This depends on 3 factors: the individual, the type of caffeine beverage consumed and hydration levels. Here is how:

The Individual

While caffeine intake can usually reduce the rate of kidney stone formation on the average person, for an individual prone to kidney stones (by genetics, demographic factors, medical conditions etc), it is not always the same case. This is because, for certain individuals, caffeine can increase calcium levels or in medical terms, hypercalciuria, leading to the most common type of kidney stone, calcium oxalate.

Type of Caffeinated Beverage Consumed

Nescafe Iced Coffee

While general coffee poses an increased risk of kidney stones by dehydration factors and by increasing urine production, iced coffee is sometimes made with other additives like milk, ice cream or creamers which can increase calcium excursion, blood sugar and sometimes oxalate levels. Nescafe Iced coffee also contains 75 mg of potassium, which also plays a role in kidney function. Potassium citrate helps prevent kidney stones by binding with calcium in the gut before entering the kidneys. However, the potassium in Nescafe Iced Coffee is potassium chloride which does not offer the same protective benefits, and instead, can potentially alkalize urine pH levels making a more favorable space for uric acid and calcium oxalate stones to form. However, these effects would be more significant in individuals with kidney disease as for most people, potassium in coffee is not a major issue.

Monster Energy Drinks

The average Monster Energy Drink contains relatively unsafe levels of ingredients assisting with kidney stone development. For instance, one can hold about 137-166 mg of caffeine which as a diuretic, increases urine production leading to dehydration and solute concentration in the urine. But caffeine isn't the only problem, some Monster Energy Drinks contain about 54g of sugar which is more than 12 ½ teaspoons! This alarming concentration of sugar can rapidly increase blood sugar levels also increasing urine production. Furthermore, Monster Energy Drinks also contain sodium levels reaching as high as 370 mg, that is 15-25% of the amount you should have in an entire day! Studies also show that 11-61% of increasing kidney stone cases are because of excessive sodium intake. This is because of its nature to cause the kidneys to excrete unsafe levels of calcium in the urine. And lastly, Zero Sugar Monster Energy Drinks also contain artificial sweeteners in the form of sucralose to act as a sugar substitute. These sweeteners usually go under the category of oxalates and contribute to kidney stones when combined with calcium, forming mostly calcium oxalate kidney stones.

President's Choice Granola Bars

President's Choice Granola Bars contain high amounts of oxalates, sodium and sugar making them highly contributory to kidney stone formation. To start, President's Choice Granola Bars contain large amounts of oxalate in the form of dark chocolate chips which are made with cocoa butter and unsweetened chocolate. These ingredients can then bind with calcium in the kidneys to form calcium oxalate stones. Secondly, sugar content. President's Choice Granola Bars contain a considerable amount of sugar, honey, glucose, fructose, vanilla extract and fancy

molasses; all sweeteners with the ability to increase calcium excursion and fructose with the ability to increase levels of uric acid. Furthermore, President's Choice Granola bars contain 45 mg of sodium which while is a negligible amount, if consumed regularly without adequate water intake, can contribute to calcium excursion and in worse cases kidney stone development.

Hydration Levels

While caffeine is a diuretic, it is made up of 95% water making its diuretic effects significantly low. This means caffeine can cause mild effects on dehydration making it negligible to the formation of kidney stones. However, the build up of these "low" dehydration factors can still contribute to the concentration of urine increasing stone risk.

How does Caffeine increase the risk of Calcium Oxalate stones?

As explained in the previous diagrams, caffeine can cause mild dehydration and can contribute to an increase of calcium excursion. But what if I was to tell you that these factors contribute most to calcium oxalate stones? While other kidney stones are formed by factors such as high protein diets or UTIs, calcium oxalate stones are formed mostly by dehydration and excessive urine build up, making an individual with high caffeine intake more prone to them.

How does Caffeine influence urine acidity or alkalinity?

While caffeine does not significantly alter urine pH levels, a neighboring factor such as the type of caffeinated substance can subsequently lead to a range of different urine pH levels. For instance, coffees and teas contain organic acids like chlorogenic acids contributing to acidic or low pH levels while beverages like Monster Energy drinks contain inorganic additives such as sodium bicarbonate, known to cause alkaline or high pH levels in the urine.

How does urine acidity or alkalinity affect kidney stone formation?

Kidney stones form in an environment made up of mostly urine, making them strongly impacted by urinary pH levels.

Type of Kidney Stone	pH Level	Reason
Calcium Oxalate	Acidic/Neutral (>5.0–6.5)	❖ Oxalate is more soluble in acidic urine ❖ Can still form in alkaline urine
Calcium Phosphate	Alkaline (<7.0)	❖ More likely to form in high pH levels
Uric Acid	Acidic (>5.5)	❖ Uric Acid is less soluble in alkaline urine
Struvite	Alkaline (<7.0)	❖ Struvite Stones are formed by UTI's ❖ Bacteria can make urine more alkaline
Cystine	Acidic (>6.5)	❖ Cystine is less soluble in alkaline urine

What is Substance Abuse?

Majority of people who consume drug substances consume them out of pleasure, as a coping mechanism or even just for amusement. However, they do not know the serious health risks that may come along with this dangerous consumption. Many addictive substances can lead to severe mental health disorders, organ damage, a severe buildup of intoxicants or in severe cases, heart disease, diabetes and even kidney dysfunction; all severe health conditions leading to complications or even death. While the short term effects may seem amusing and harmless, the short-term effects can be incredibly painful and devastating, putting all of the delight to waste.

What are Gateway Drugs?

A gateway drug is a “softer” drug substance, which when consumed frequently can increase dopamine levels, increasing pleasure, leading people to crave more addictive, harmful and illicit substances such as cocaine, opioids or ecstasy. Gateway substances are typically the drug most people would start with as they are served at bars, clubs and parties. A few of the most common gateway drugs consumed (especially by teens and young adults) are alcohol, nicotine and marijuana.

How do Gateway Drugs affect Kidney Function?

Chronic gateway drug consumption can deliberately lead to fluid imbalance as these substances interfere with the regulation of vasopressin, an antidiuretic hormone (ADH) assisting the kidneys by controlling the amount of urine that the body makes in regards to water retention. However, many gateway drugs, especially alcohol can restrict vasopressin release, causing the kidneys to release water into the bladder before redirecting it into the rest of the body. This displacement not only causes more urine to build up than normal, but also results in excessive fluid and electrolyte imbalances.

What is the relationship between gateway drugs and kidney stones?

Gateway drug use can damage the kidneys and increase the risk of kidney stone formation through processes like dehydration, oxidative stress and mineral imbalances. Although not all drugs can contribute to kidney stones directly, many contribute to conditions that make the formation more likely. Here is how:

The Individual

Like caffeine, the effect drug consumption has on the formation can vary depending on the individual's lifestyle, genetics and medical conditions. For example, Some individuals with conditions like heart failure or diabetes, may be more vulnerable to dehydration or mineral imbalances caused by the consumption of gateway drugs, subsequently leading to the likelihood of kidney stones.

Rhabdomyolysis

Rhabdomyolysis is a life threatening condition commonly linked to substances like heroin and cocaine causing the muscles to break down. The kidneys are responsible for removing the break-up of muscle fragments (potassium, phosphate, etc.) but, if they can not get rid of these wastes quick enough, rhabdomyolysis can release excessive calcium and uric acid into the blood leading to the formation of a kidney stone.

Type of Gateway Drug Consumed

Different drugs can have different effects on the overall dynamic of the kidney and the formation of kidney stones. In a nutshell let's look at a few:

Alcohol

While alcohol itself doesn't directly cause kidney stones, overdosing in certain alcoholic beverages can impair kidney function subsequently worsening the risk of this kidney disease. To begin, alcohol is a diuretic, causing the body to excrete more urine than normal. This can concentrate and build up levels of stone forming solutes like calcium and uric acid. Some alcoholic beverages like beer and liquor also contain exogenous purines, a molecule that breaks down into uric acid, which when consumed regularly, can build up and accumulate to form uric acid stones. Alcohol can also impair the kidneys ability to maintain the right amount of water in the body, as when there is a heavy build up of urine in the renal pelvis, the kidneys find the need to excrete as much of it as possible to maintain balance. This excursion can cause an incipient loss of urine volume leading to dehydration and concentrated minerals potentially leading to kidney stone formation. Additionally, some alcoholic beverages like wine and beer contain oxalates, which when binded with calcium can concentrate the urine (especially if the consumer is dehydrated) and contribute to calcium oxalate stones. Chronic alcohol consumption

can also reduce vitamin D in the body thus reducing calcium absorption and causing calcium imbalance as alcohol can damage the liver, the organ responsible for converting vitamin D from food into 25-hydroxyvitamin D (25 (OH) D), the major form of vitamin D circulating in the bloodstream which is later converted into calcitriol (1,25-dihydroxyvitamin D by a process called hydroxylation. This can cause calcium imbalance because when alcohol impairs the liver, it also impairs the conversion of 25 (OH) D into calcitriol which is the hormone responsible for maintaining the regulation of calcium and phosphate in the body. When this hormone is damaged or ceases to function properly, it could lead to an increase in calcium or phosphate levels in the urine thus leading to either calcium oxalate or calcium phosphate stones.

Nicotine

Like alcohol, nicotine does not directly cause kidney stones, however, it can cause various impairments to kidney function subsequently leading to this kidney disease. For instance, nicotine is a bladder irritant meaning it can cause an overactive bladder (OAB), damaging the sensitive lining of the bladder to such an extent that it increases the frequency one may need to urinate. This happens because nicotine consumption triggers nicotinic acetylcholine receptors (nAChRs) in the nervous system, receptors responsible for releasing amounts of epinephrine, norepinephrine, and acetylcholine which induce detrusor muscle contractions in the bladder, emptying it via urethra even when it isn't full. Additionally, nicotine can also cause coughing spasms, which can place pressure on the bladder causing leakage of urine. It can also weaken pelvic floor muscles, making bladder control more difficult, supporting this factor. Nicotine can also be a major cause of oxidative stress. Oxidative stress is when there is an increase of highly reactive molecules called free radicals or reactive oxygen species (ROS) (molecules that can cause chronic diseases and tissue damage) and there are not enough antioxidants to suppress them. This can be a subsequent cause of kidney stone formation as oxidative stress can cause damage and eject stone-forming minerals into your system. Nicotine is also a large factor in regards to ejection of stone-forming minerals as like alcohol, nicotine is a diuretic. And lastly, nicotine has been shown to hamper bone development and density making its effects associated with the Parathyroid hormone (PTH). The Parathyroid hormone is a hormone produced by the parathyroid glands that is released in response to low calcium levels in the blood. It is released by stimulating osteoclasts to break down the bones to collect calcium and phosphate from them into the bloodstream to then have calcium reabsorbed by the kidneys, back into the bloodstream instead of letting it get lost in the urine, and have the phosphate excreted into the urine instead. However, short-term nicotine exposure can disrupt the calcium-sensing receptors (CaSR) in the parathyroid glands making them less responsive to low calcium levels, decreasing PTH release. What this does is when the blood is in need of calcium, instead of signaling the kidneys to reabsorb the calcium back into the bloodstream, it allows the calcium to be excreted into the urine. This does not only decrease calcium levels in the blood (hypocalcemia), but can also lead to excessive calcium excursion in the urine (hypercalciuria), allowing minerals like oxalates or phosphates to bind with it and eventually nucleate forming kidney stones. This is a condition known as hypoparathyroidism. Furthermore, long-term nicotine exposure can cause secondary hyperparathyroidism, a rare condition in which abnormal amounts of PTH is released by the parathyroid hormones by an external factor (in our case nicotine) leading to excessive amounts of calcium in the urine (hypercalciuria). This

happens because over consuming nicotine can decrease vitamin D levels, making calcium absorption in the intestines and blood notably low (hypocalcemia). At this stage, excessive PTH will be released leading to osteoporosis (excessive bone breakdown caused by osteoclasts collecting too much calcium and phosphate from them) and hypercalciuria (excessive calcium excursion in urine), because when the PTH glands produce too much calcium and phosphate, the kidneys may not be able to reabsorb all of it back into the bloodstream leading to excessive amounts of it in the urine, further aiding in calcium phosphate or oxalate kidney stone formation if binded together.

What are Gateway Drugs?

Illicit drugs are "harder" drugs, typically consumed after finding pleasure in gateway drugs and craving to have something more powerful. The effects of using such drugs include: chronic diseases (liver, kidneys, etc.), blood borne viruses and even mental health problems and increased suicide risks. Illicit drugs are the same thing as illegal drugs meaning they are drugs which were not prescribed by a professional and instead were bought at a drugstore. Examples of illicit drugs include heroin, Hallucinogens and even cocaine and MDMA/Ecstasy, which we will be looking at now:

Cocaine

Frequent consumption of cocaine can cause the blood vessels to narrow just enough to block the passageway of blood flow to the kidneys (vasoconstriction). This can be a subsequent cause of oxidative stress (imbalance of antioxidants in the body) and changing the balance of minerals calcium, inducing kidney stone risk.

Methylenedioxymethamphetamine (MDMA) / Ecstasy

Ecstasy, the street name for Methylenedioxymethamphetamine (MDMA), is a widely abused drug declining the kidneys ability to function by a syndrome known as hyponatremia (decrease in sodium levels in blood [135-145 milliequivalents per liter]) that can be mild to life threatening. MDMA can also potentially lead to stone formation by hyperthermia (body temperature is higher than normal [98.6 °F / 37 °C]), a common syndrome caused by MDMA, concentrating minerals in the urine. Dehydration also plays a role as it is affected significantly by MDMA.

Hydration Levels

Various drugs including cocaine and MDMA contribute to the cause of overheating and dehydration by impairing the kidneys ability to regulate fluids. Dehydration is a direct cause of concentrated urine, which allows the urine minerals to get saturated and nucleate.

Background Research

This research is not linked to caffeine or addictive substances. However, it was written to help educate us on why kidney stone prevention is so important by researching the symptoms, potential infections/diseases involved, surgeries and many more.

How do Kidney Stones affect Kidney Function?

Interesting enough, kidney stones do not affect kidney function the moment that they are formed. Rather they cause significant changes when they detach themselves from the kidney tissue or the renal pelvis and enter the ureter, the tubes that connect the kidneys and the bladder. The walls of the ureters are lined with smooth muscles that contract to push urine by peristalsis. These contractions also help push the stone along, but because the ureters are very narrow, the stone can cause stretching, swelling, involuntary ureter contractions (spasm) and even cause one to tremble from pain in their sides and back in their lower abdomen. At this stage, 3 things may happen:

1. Blockage of Urine Flow (Ureteral Obstruction)

Most kidney stones are small (less than 5 mm) and pass on their own without causing any symptoms, pain and little to no harm to the ureter or urinary tract. However, some kidney stones are larger in scale (more than 5 mm) and can get lodged in the ureters, blocking urine flow (ureteral obstruction). Ureteral obstruction also prevents urine from entering the bladder and exiting the body via urethra. If this obstruction is not treated and removed, one may develop a condition called hydronephrosis.

Hydronephrosis

Hydronephrosis is the buildup of urine in one of or both of the kidney(s) in the renal pelvis. This buildup is usually caused by a blockage in the urinary tract blocking the passageway for urine to exit the body through the urethra and instead, flow the back up into the kidney causing the kidney to swell and stretch and even develop a condition called necrosis (death of body tissue). This can cause one to feel excruciating side and back pain, fever, vomiting and painful urination. Sometimes, professionals may grade the level of hydronephrosis on a scale of 1 to 4, 1 representing minimal dilation and 4 representing extreme dilation. But, what factors of ureteral obstruction affect the severity of dilation? In a nutshell, here are a few:

- Degree of obstruction
- Duration of Obstruction
- Stone Compounds and size
- Kidney Function
- Presence of infection
- Time of detection

2. Infection

Urinary Tract Infection (UTI) is a common infection caused by bacteria that enter your body through the urethra and multiply, infecting the urinary tract. UTI's need significant medical treatment. If treated poorly or after a long period of time, the bacteria can spread into the bloodstream (septicaemia) causing long lasting kidney damage and severe infections such as urethritis, abscess, cystitis or pyelonephritis, a serious infection that resides in the kidneys most commonly by kidney stones themselves. UTI can also cause septic shock, further damaging the kidneys.

3. Kidney Failure

Kidney stones usually do not have any long-term effects as healthcare professionals are usually able to remove ureteral blockages before any severe kidney damage occurs. However, in severe cases, if a ureteral obstruction remains untreated it can lead to kidney failure and even death. Here is a detailed explanation on the relationship between kidney stones and kidney failure analyzing both acute and chronic kidney failure:

Acute Kidney Injury (AKI)

Acute Kidney Injury (AKI), also known as Acute Renal Failure (ARF) is a disorder where the kidney is suddenly unable to function. This is a severe condition that can develop within a few hours or days. Most people can develop AKI within 48 hours but for others it can take as long as 7 days. Kidney stones can cause AKI in the following ways:

Bilateral Obstruction (BUO)

Bilateral Ureteral Obstruction (BUO) is the blockage in both ureters and can cause such a severe dilation to the renal pelvis (kidney gland that collects urine) that it blocks kidney function entirely (hydronephrosis). However, the development of AKI depends on how quickly the obstruction is treated. If the ureters are obstructed for a long period of time, it can increase pressure in the kidneys, damage kidney tissues and reduce blood flow leading to moderate to severe levels of AKI. On the other hand, if the obstruction is treated and removed early on, it can prevent AKI even in cases of severe dilation

Chronic Kidney Disease (CKD)

Chronic Kidney Disease (CKD), also known as chronic kidney failure, is a term used to describe a repetitive and irreversible loss of kidney function over time. Advanced CKD can even cause dangerous levels of waste, fluid and electrolytes to build up in your body. Chronic episodes of kidney stones can trigger CKD through recurrent obstructions, fibrosis (tissue scarring), and loss of nephrons (blood filters in kidney).

End Stage Renal Disease (ESRD)

End stage renal disease (ESRD), also called end stage renal failure, is the last and permanent stage of CKD, where the kidney function has declined so severely that it has reached the point where it is not able to function on its own. However, the odds of kidney stones being a direct cause of ESRD is relatively low, but there are still some possible factors that can influence the risk of ESRD directly from kidney stones such as:

- Struvite and cystine stones
- Recurrent kidney stones
- Delayed diagnosis / Poor treatment
- Infections
- Acute kidney injury (AKI)

A patient with ESRD must receive dialysis (a treatment that filters and removes extra fluid from the body) or a kidney transplantation in order to survive for more than a few days.

How are Kidney Stones Diagnosed?

Kidney stones can cause excruciating pain to an individual leading them to seek immediate medical attention. At this stage after taking note of your condition, symptoms, family history and risk factors, a professional may proceed to take these diagnostic procedures:

Urinalysis Tests

Urine tests, also known as urinalysis, is a 24 hour urine collection test showcasing whether or not your body is producing high concentrations of uric acid, or any other minerals contributing to the development of kidney stones. It can also detect many disorders including, UTI's, diabetes and kidney disease. Urinalysis can cause a common kidney stone symptom called hematuria, or blood in urine.

Hematuria

Hematuria is the medical term for the presence of red blood cells in urine. While it is a common indicator of kidney stones, it can also be a symptom of UTI or other kidney diseases. In the case of kidney stones, hematuria often occurs when the stone moves or remains anchored in the narrow space of the ureter, the sharp edges of the stone begin scraping its frail, delicate lining causing minor bleeding. Hematuria can be of 2 types, gross and microscopic, gross hematuria is when there is enough blood present in the urine that you can see with your naked eye. On the other hand, microscopic hematuria is when your urine does have small amounts of blood in it but is not visible with other than a microscope.

Blood Tests

Blood tests are another way professionals may diagnose kidney stones. While these tests cannot determine whether or not you have a stone, it can monitor high levels of calcium and uric

acid in the blood, which can contribute to the final diagnosis of kidney stones. Blood tests can also monitor how healthy your kidneys are, allowing your doctor to check you for any other medical conditions.

Imaging Tests

After diagnosing a patient for kidney stones, a professional usually uses imaging tests to locate where the stone is in the urinary tract. The types of imaging tests used for diagnosing kidney stones include:

Abdominal X-Ray

While it is not frequently used on an average patient, abdominal X-Rays can be a great way a professional can view the placement of larger kidney stones on a patient with other medical conditions like pregnancy, as these scans use low levels of radiation making it safer for a pregnant woman and her baby. However, abdominal X-Rays can sometimes miss smaller stones reducing its accuracy when dealing with an average patient.

Computed Tomography (CT) Scan

Unlike X-Rays, CT scans provide accuracy revealing even the tiniest of stones. They can also provide a clear picture of where the stone is located, whether or not it is creating ureteral obstruction, and even the conditions that may have caused the stone to form.

Ultrasound

An ultrasound is another tool used on a patient to detect the placement of kidney stones. While there is not too much information on this diagnostic exam in relation to kidney stones, it can be inferred that it is relatively safe as it produces low levels of radiation making it suitable for patients with external medical conditions.

Analysis of Passed Stones

A kidney stone analysis is a lab test to see what chemicals the kidney stone is made up of (calcium, uric acid, etc.) the test is done on a kidney stone either passed through the urethra (a professional may ask you to urinate through a strainer or a stent to catch the stone) or on a kidney stone that was removed during surgery. They may also prescribe you with a medication known as floxate, a drug used to reduce muscle retention. A chemical analysis of a kidney stone can not only guide treatment but can also provide your doctor with enough information to determine what caused your kidney stone(s) and what protective measures you can take to avoid kidney stones in the future.

What Procedures Are Used to Remove Kidney Stones?

While most kidney stones can pass on their own, sometimes a stone can be so large that it gets lodged into the ureters having no way to exit your body, at this stage it is called obstructive ureterolithiasis. When this happens your doctor may consider surgery as the most profound treatment. The types of kidney stone surgeries include :

Ureteroscopy (URS)

Ureteroscopy (URS) is the most common procedure used to treat kidney stones. It involves the passageway via urethra, of a long, thin tube called a ureteroscope, consisting of an eyepiece on one end and a small lens and light on the other, similar to a telescope. This device is used to locate the stone in the ureter as well as determine its size and composition so that your healthcare provider can identify the best ureteroscopy surgery for you. Ureteroscopy surgeries are of 2 types:

1. Basket Extraction

A Basket Extraction is a ureteroscopy procedure used for extracting small kidney stones. This extraction tool is an extended version of a ureteroscope in which an extra channel holds a wire basket, A device that can collect the stone whole and guide it down to the bladder before passing it out through the urethral opening.

2. Laser Lithotripsy

In cases of a large kidney stone, a healthcare professional may suggest a laser lithotripsy ureteroscopy. In this procedure, a flexible fiber with a laser beam illuminating through the lens, with rays strong enough to break apart the stone into small fragments. These fragments are then individually extracted from the body using a wire basket. Both Ureteroscopy techniques require no incision and little to no pain as a patient is put into anesthesia. Furthermore, a ureteroscopic surgery takes no longer than 1 to 3 hours for the average patient making it an outpatient procedure (letting you go home the same day). However, there are significant risk factors going through with this procedure such as UTI's and injuries to the ureter, though this can easily be prevented as a professional will prescribe you with antibiotics after the surgery to reduce the risk.

Shockwave Lithotripsy (SWL)

Shockwave lithotripsy (SWL) also called Extracorporeal shockwave lithotripsy (ESWL), is a procedure used for stones softer and less than 2 centimeters in size. In this procedure, a professional uses an X-Ray to locate the stone and soundwaves to break it up. These soundwaves (several hundred to thousands) are transmitted out of a device called a lithotripter. These broken fragments are then passed naturally with the urine. Like Ureteroscopy, ESWL is an outpatient procedure, spanning over 30 minutes to an hour, depending on the stone size, hardness and location. It is also a considerably safe procedure with high success rates, no pain as a patient is put under anesthesia, natural stone passing, and for most patients, short

recovery time, allowing you to return to your normal lifestyle within a few days. However, some patients may experience hematuria or slight discomfort in their body though can easily be prevented by increasing your water intake to help stone fragments pass and by asking your doctor for oral pain medications such as aspirins to reduce discomfort.

Percutaneous Nephrolithotomy (PCNL)

Percutaneous Nephrolithotomy (PCNL) is a major surgery when it comes to kidney stones. It is done when other surgeries are unsuccessful or on larger stones. In this procedure, a professional will make a small incision in your back or side and then remove the kidney stone with a instrument called a nephroscope to locate the stone and then use ultrasonic or laser energy to break the stone into smaller fragments and then remove it or use other tools attached to the nephroscope to remove it entirely. PCNL is a highly effective surgery with high success rates and like other kidney surgeries, a patient experiences no pain as they are under anesthesia. However, unlike the other procedures after a PCNL takes place, a patient would need to stay about a day or two in the hospital before going home. The aftermath of the procedure is also usually moderately painful to most patients though a healthcare provider can prescribe you with painkillers to reduce the pain.

Who is most likely to develop Kidney Stones?

Demographic Factors:

- Gender: Men
- Age: 30-60
- Ethnicity: Non-hispanic white individuals

Medical History:

Family History: Having a family member who has had kidney stones in the past increases your risk of developing kidney stones significantly.

Personal History: Having a kidney stone in the past increases the chance of developing one again (recurrent nephrolithiasis)

Environmental Factors:

- **Individuals living in hot climates are more prone to kidney stones due to dehydration.**

Medical Conditions:

- Diabetes
- Urinary Tract Infection (UTI)
- Renal tubular acidosis

- Cystinuria
- Hyperparathyroidism
- Many More!

What symptoms do Kidney Stones Cause?

- Colicky pain on the sides/back
- Constant stomach ache
- Foul smelling ; cloudy urine
- Blood in urine (hematuria)
- Fever
- Nausea
- Chills
- Vomiting

“Both of my kidney stones remained lodged in my ureters for about 2 weeks causing me excruciating pain. I felt sharp, colicky pain in the left side of my bladder causing me to shiver in agony when an ambulance had driven me to the hospital. By far, the most painful experience of my life.”

- Akbar Rais

What medications are used to treat Kidney Stones?

- Alpha Blocker
- Thiazide Diuretics
- Allopurinol
- Potassium Citrate

Conclusion

In conclusion, my hypothesis was mostly correct. Caffeine and addictive substances have an effect on kidney stone formation through processes like oxidative stress and mineral imbalances, but also dehydration, which teaches us the importance of staying hydrated as this is one of the most important factors contributing to kidney stones.

In regards to my hypothetical guesses on which substances had a greater impact on kidney stone formation, my results were:

Caffeine: I was correct, Monster Energy drinks pose a greater risk as it acts as a diuretic and is highly acidic, increases calcium excursion and promotes insulin resistance. Nescafe Iced Coffee can also fall as a close second if heavily sweetened. While President's Choice granola bars do

not contain many oxalates, excess acid or caffeine making them unlikely to contribute to kidney stone formation.

Illicit Drugs: I was incorrect, I hypothesized that cocaine is of greater effect but it is actually MDMA. This is because MDMA poses for more long term and serious effects as MDMA can cause severe overheating and therefore chronic dehydration. Cocaine can also cause many similar effects, however cocaine poses to cause kidney damage rather than cause kidney stones.

Gateway Drugs: I was correct, Alcohol poses a greater risk of kidney stones in comparison to nicotine as many alcoholic beverages contain heavy concentrations of oxalates and have many other effects in relation to calcium excursion and dehydration. While nicotine also has similar qualities, long term exposure is what would cause them, whereas alcohol can in a shorter period of time.

And finally, my hypothesis on the greatest substance acting on kidney stone formation was also correct. It is true that addictive substances have a greater impact on kidney stones than caffeine due to their more severe effects on kidney dysfunction leading to this kidney disease. This is also because caffeine contributes to about 5% of urine concentration as the other 95%'s diuretic effect is notably low. As for addictive substances, they have more indirect yet serious impacts on kidney stones affecting around 5-10% of kidney stone cases. However, this is a rough estimate as studies linking addictive substances to kidney stones are very limited. For a more accurate estimation, this topic may require further study.

It is also true that illicit drugs have a greater impact on kidney stone formation due to the fact that illicit drugs are much stronger and can cause many health defects and medical conditions.