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What Does the Science Say About Alcohol Consumption?

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Alcohol consumption, even at low levels, can negatively impact brain structure, reducing overall brain volume and affecting gray and white matter integrity

Ethanol in alcoholic drinks is converted to acetaldehyde, a toxic substance that damages cells indiscriminately, leading to various health issues including increased cancer risk

Alcohol disrupts gut health by killing beneficial bacteria, potentially causing leaky gut syndrome and triggering inflammatory responses that affect your liver and brain

Regular alcohol consumption can alter hormonal balance, increasing estrogen levels and potentially raising cancer risk, especially for breast cancer

While N-acetylcysteine (NAC) supplementation may help mitigate some harmful effects of alcohol, abstaining completely is the safest option for optimal health

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In the Everyday Wellness podcast above, Brooke Scheller, a doctor of Clinical Nutrition, founder of Functional Sobriety (a nutrition-based program for alcohol reduction) and author of "How to Eat to Change How You Drink," discusses the impact of alcohol on your brain and body. I recently interviewed Brooke and will have her interview up in the next few weeks.

While I don't recommend drinking alcohol, historically humans have been consuming it for thousands of years, including for recreational and medicinal purposes. The first instance of alcohol distillation can be traced back to China in the 1st century,[1] while alcohol has served various purposes throughout history:

1. Nutritional — Some cultures believed, and some still do, that alcohol provides valuable calories, though they're actually "empty calories."

2. Medicinal — Alcohol's ability to kill bacteria made it useful for medical purposes. However, it also destroys beneficial gut bacteria, potentially leading to issues like leaky gut syndrome.

2. Recreational — The primary reason for alcohol consumption has been to alter one's mental state. Many people seek the feeling of intoxication, despite the subsequent negative effects such as decreased happiness, motivation and increased stress.

Are Small Amounts of Alcohol Bad for Your Brain?

It's often suggested that while heavy alcohol consumption is harmful, small or moderate amounts may provide some benefits. However, evidence suggests that alcohol consumption, even at low levels, may carry more risks than benefits for overall health.

According to a study from the UK Biobank that examined brain scans of 36,678 middle-aged and older adults,[2] even just one to two alcoholic drinks per day is associated with negative changes in brain structure, including reductions in overall brain volume, gray matter and white matter integrity.

The brain consists of two main types of tissue: gray matter and white matter. Gray matter comprises neuron cell bodies, which contain the cells' genetic material. White matter, on the other hand, is made up of axons – long fibers extending from neurons. These axons are coated with a fatty substance called myelin, giving white matter its characteristic appearance.

This myelin sheath enables rapid communication between nerve cells, facilitating efficient information transfer throughout the brain.

The study demonstrates that the negative effects on brain structure are not limited to heavy drinkers but are observable even at low levels of alcohol intake. As consumption increases, so does the severity of these structural changes. This research provides compelling evidence that there may be no "safe" level of alcohol consumption when it comes to brain health.

A review published in Frontiers in Neuroscience also addressed the complex interplay between alcohol consumption and cognitive decline, noting that chronic alcohol abuse leads to "changes in neuronal structure caused by complex neuroadaptations in the brain."[3]

Alcohol Is Converted Into the Poison Acetaldehyde

Ethanol, the type of alcohol in drinks, is both water-soluble and fat-soluble. This allows it to easily pass into all cells and tissues of your body. When ingested, ethanol is converted to acetaldehyde, which is a well-known poison that indiscriminately damages and kills cells. Your body then converts acetaldehyde to acetate, which can be used as fuel. However, this process is metabolically costly and provides no real nutritive value.

When you consume alcohol, it enters your stomach, then your liver starts converting the ethanol to acetaldehyde and then to acetate. Some of these byproducts reach your brain by crossing the blood-brain barrier (BBB).

The blood-brain barrier (BBB) is a protective mechanism that prevents most substances from entering the brain. However, alcohol is an exception due to its unique property of being both water- and fat-soluble. This characteristic allows alcohol to easily penetrate the BBB and enter the brain tissue.

Once inside, alcohol interacts with and affects the brain's internal environment, which is primarily composed of two major cell types: neurons (nerve cells) and glial cells (found between neurons). The presence of alcohol in the brain disrupts normal neural circuit function, leading to the various effects associated with intoxication.

Among alcohol's effects is suppression of activity in the prefrontal cortex, a brain area involved in impulse control and decision-making. As alcohol suppresses prefrontal cortex activity, people become more impulsive and less inhibited.

What's less known, however, is that alcohol-induced changes in neural circuits can persist long term, even if you don't drink heavily. Drinking patterns like having one or two drinks per night or drinking only on weekends, for instance, can lead to changes in the brain's circuitry for habitual and impulsive behavior. These changes can continue even when not drinking, potentially making people more impulsive in their daily lives.

Fortunately, these changes are not permanent in most cases. A period of abstinence, typically ranging from two to six months, can allow these neural circuits to return to their normal state. The exception is in cases of chronic, heavy alcohol consumption over many years, where the changes may be more persistent.

It's also important to distinguish between being "blackout drunk" and passing out. During a blackout, an individual may still be active and conscious, but their hippocampus — a brain region crucial for memory formation — is temporarily impaired. This results in an inability to form new memories, leading to no recollection of events the following day, despite the person having been awake and functional during that time.

Alcohol Damages Your Gut Health

Alcohol negatively affects your gut microbiome and gut-liver-brain axis, a bidirectional communication network that links these three crucial systems in your body. Alcohol's antimicrobial properties, which make it effective for sterilization, also indiscriminately kill beneficial gut bacteria.

For instance, alcohol consumption may decrease Akkermansia muciniphila, a beneficial bacterial species naturally found in the human gut.[4] This, in turn, is associated with "dysregulation of microbial metabolite production, impaired intestinal permeability, induction of chronic inflammation, and production of cytokines."[5]

The metabolism of alcohol in your liver also triggers a proinflammatory response, releasing cytokines such as IL-6 and tumor necrosis factor alpha. This inflammatory reaction, combined with the disruption of gut bacteria, can lead to a condition known as "leaky gut." In this state, harmful bacteria from partially digested food can escape your gut and enter your bloodstream.

The simultaneous occurrence of good bacteria die-off and bad bacteria infiltration creates a "two-hit" model, where the combined effects are more severe than each issue individually. These gut and liver disturbances have far-reaching consequences, Huberman explains, particularly on your brain.

Through neuroimmune signaling, inflammatory molecules can cross your blood-brain barrier, disrupting neural circuits that regulate alcohol consumption. Paradoxically, this disruption often results in increased alcohol intake, creating a vicious cycle of gut microbiome disruption, liver inflammation and altered brain function.

This self-perpetuating process explains why regular drinkers, even those who don't consume

large quantities, may find themselves caught in a pattern of increasing alcohol consumption and worsening systemic inflammation.[6]

Meanwhile, pathogenic oxygen-tolerant bacteria secrete a very virulent form of endotoxin, also known as lipopolysaccharides (LPS), which can cause inflammation if they translocate across the compromised gut barrier into the systemic circulation.

Even one episode of binge drinking results in increased endotoxin levels, "likely due to translocation of gut bacterial products and disturbs innate immune responses that can contribute to the deleterious effects of binge drinking," researchers wrote in PLOS One.[7]

A study published in Scientific Reports also found that excessive drinkers had an increase in levels of LPS,[8] while, among alcohol-dependent adults, avoiding alcohol for 19 days led to significant reductions in gut permeability.[9]

Even Light Drinkers May be at Risk of Premature Death

A systematic review and meta-analysis of 107 cohort studies involving more than 4.8 million people revealed that drinking less than two drinks a day is not associated with reductions in risk of all-cause mortality.[10] Further, drinking more than this may significantly shorten life expectancy.

The study's lead author, Tim Stockwell, a scientist with the Canadian Institute for Substance Use Research, told the Daily Mail that drinking about two drinks per week over your lifetime may cut your life short by three to six days. Drinking seven drinks a week may shave 2.5 months off life expectancy, while consuming about 35 drinks per week may reduce lifespan by about two years.[11]

One reason for this detrimental effect could be alcohol's link to cortisol. Regular alcohol consumption, even at moderate levels, can lead to changes in the hypothalamic-pituitary-adrenal (HPA) axis.

This alteration in the HPA axis can result in higher baseline cortisol levels when not drinking. In other words, individuals who drink regularly may experience elevated levels of cortisol, often referred to as the "stress hormone," even during periods when they are not consuming alcohol. This persistent increase in baseline cortisol can have various negative impacts on overall health and well-being.

This means that regular drinkers may actually feel more stressed and anxious when they're not consuming alcohol. Further, while cortisol plays a vital role in your health, it can lead to severe health issues like muscle breakdown, inflammation and impaired immune function when chronically elevated, which is why keeping your levels in check is so important.

Alcohol Increases Estrogen Levels and Cancer Risk

Drinking alcohol affects your hormones, particularly the balance between testosterone and estrogen. Alcohol tends to increase the conversion of testosterone to estrogen,[12] which can have various negative effects in both men and women. Estrogens are one of the primary factors contributing to increasing your cancer risk.

Alcohol also increases cancer risk via acetaldehyde toxicity, which can cause DNA damage, inflammation, leaky gut and weakened immune function. Drinking alcohol also disrupts sleep, which means you're not getting a restorative night's sleep when you drink. Further, acetaldehyde toxicity can alter DNA methylation and gene expression, which raises your cancer risk as well.

How to Mitigate Some of Alcohol's Harmful Effects

I don't recommend drinking alcohol, and the best way to avoid its harmful effects is to simply not drink it. If you do plan to have an alcoholic beverage, however, N-acetylcysteine (NAC) supplementation can be used as a preventive measure when taken beforehand. NAC is a derivative of the amino acid cysteine, which not only boosts glutathione levels but also helps mitigate acetaldehyde toxicity, a primary cause of hangover symptoms.

Taking at least 200 milligrams of NAC about 30 minutes before drinking may help reduce alcohol's toxic effects. The efficacy of NAC is thought to be enhanced when combined with vitamin B1 (thiamine). Additionally, vitamin B6 may help alleviate hangover symptoms.

Since alcohol consumption depletes B vitamins, which are necessary for alcohol elimination from your body, taking a B vitamin supplement before and after drinking can be beneficial. However, it's crucial to note that this approach does not protect against alcohol poisoning or other serious risks associated with excessive drinking.

Therefore, it's essential to consume alcohol responsibly and in moderation, regardless of any preventive measures taken. For optimal health, however, consider avoiding alcohol completely and instead exploring alternative methods for stress reduction and social interaction that don't involve drinking.

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Notes

[1] YouTube, Andrew Huberman, What Alcohol Does to Your Body, Brain & Health August 22, 2022, 10:52

[2] Nature Communications, Volume 13, Article number: 1175 (2022)

[3] Front. Neurosci., 05 July 2019

[4, 5] Molecular Nutrition & Food Research

[6] YouTube, Andrew Huberman, What Alcohol Does to Your Body, Brain & Health August 22, 2022, 55:12

[7] PLOS One May 14, 2014

[8] Scientific Reports, Volume 7, Article number: 4462 (2017)

[9] PNAS October 6, 2014

[10] JAMA Network Open March 31, 2023

[11] The Hill July 9, 2024

[12] Alcohol November 2000, Volume 22, Issue 3, Pages 123-127
