In July 1995, it became unusually hot in Chicago. The temperature hit 106 degrees, and the heat index which is like wind chill - how it feels to people, was 126 degrees. As mayor Richard Daley eloquently put it: "It's hot, it's hot out there! It's very very very hot." Eric Klinenberg, author Heat Wave: A Social Autopsy of Disaster in Chicago explains that Roads were buckling under the heat, and drawbridges had to be hosed down to close properly. This led to huge traffic jams; The city even had to hose down hot school buses and provide the kids with bottled water in an attempt to cool them down.

Over 700 heat related deaths were logged in as little as 5 days. While this was a difficult time for everyone, most of the victims were **elderly people**. Klinenberg points out that this is likely due to their being more isolated, and less likely to open their windows for fear of crime, even if they had no air conditioning. But what else makes the heat so dangerous for the elderly? In 2003, the European heat wave led to the hottest summer since at least 1540, leading to a death toll of more than 70,000 people. Again, the elderly were hit especially hard.

Now, as this report from the World Health Organization Europe states: "*As long as sweating is continuous, people can withstand remarkably high temperatures, provided that water and* ***sodium chloride, the most important physiological constituents of sweat****, are replaced.*"

So, if you are sweating a lot in the heat, sodium preserving systems are very important in keeping you from losing dangerous amounts of sodium. Well, these systems don't work as well in the elderly.

As this section from a volume of QJM entitled "*Why do older patients die in a heatwave?*" says: Older subjects have *"diminished renal tubular conservation of sodium and water during periods of dehydration.*" Simply put, older people in general have a harder time holding onto salt and are more at risk for hyponatremia - low blood sodium. Hyponatremia is

associated with an increased length of hospital stays, bone fractures, rhabdomyolysis and increased risk of death.

In fact, "***Nursing home patients have a forty-three-fold higher risk of being hospitalized with hyponatremia*** *compared to patients in the community.* " And of course, what is served in nursing homes is "heart healthy" low sodium food.

As I pointed out in my last video, the salt hypertension link doesn't entirely make sense when you look at consumption trends. And, there seems to be a higher risk of mortality from getting too *little* salt compared to getting too much. This study suggests that getting *less* than 3000mg of sodium causes a higher risk of mortality compared to getting far more than that. In fact actually following the WHO low salt guidelines of 2000mg would pose more of a health risk than getting 6 times that amount.

So what about our physiology would make this the case? The reason has to do with how the body reacts to low levels of sodium. As is explained in "The Salt Fix" by Dr. James DiNicolantonio, the body works very hard to conserve sodium when your intake is low. Sodium is a key component in our cells ability to function in general. Without sodium, your neurons won't fire, your muscles won't contract and several important processes cannot occur.

Normally people pee out a fair amount of sodium daily. However it has been found that when levels are low enough, the kidneys refuse to release any sodium into the urine.

When there is less sodium, the body increases activity in the renin-angiotensin-aldosterone system or the RAAS. This system begins with your liver releasing angiotensinogen, and, after a series of steps that you can read about in an endocrinology textbook, angiotensin I is produced. Angiotensin-converting enzyme (ACE) then converts it into

angiotensin II, which stimulates the adrenal glands to produce **aldosterone**. Aldosterone is important because its job is to hold on to sodium by conserving it not only in the kidney, but also in the salivary glands, sweat glands and colon.

Aldosterone has it's purpose, but it's not a hormone you want to regularly have high levels of. High aldosterone is associated with increased inflammation (R2, R3), Chronic kidney disease, Osteoporosis (R2) and cardiovascular disease. In particular it's implicated in oxidative stress and myocardial fibrosis - an abnormal thickening of the heart valves.

One more thing: Aldosterone secretion, combined with blood vessel constriction due to impairment of nitric oxide synthesis - another consequence of this renin-angiotensin aldosterone system, **increases blood pressure**. And, this blood pressure raising effect of the RAA system is well known - a common medication given to people with high blood pressure is something called an ACE Inhibitor. These drugs inhibit Angiotensin Converting Enzyme, hindering an important step in the RAA system resulting in lower aldosterone and **lower blood pressure**.

But, as I mentioned earlier, this renin angiotensin aldosterone system is stimulated by low salt intake. As this study shows, a low salt diet increases aldosterone more than 3 fold in healthy people. Another study shows that when salt intake drops below 1.5 teaspoons per day, a significant increase in renin and aldosterone occurs. Keep in mind that the WHO "strongly" recommends getting no more than 2000 mg of sodium per day, which equates to less than **one** teaspoon of salt. This suggests that people actually following the WHO guidelines are chronically raising their aldosterone.

So, how does the body react to *higher* levels of salt?

On the flip side of aldosterone, there is a group of hormones called natriuretic hormones, i.e. sodium urinating hormones. These hormones are secreted when sodium intake is increased. As is discussed in Seldin and Giebisch's The Kidney, Fifth Edition, all 9 of the different Natriuretic Hormones discussed have therapeutic effects ranging from improving kidney and heart function to preventing the growth of cancers. One of these hormones called Atrial Natriuretic Peptide, shows particular promise for promoting the health of blood vessels. In fact the therapeutic potential of this peptide is significant enough that it has recently been approved in Japan to treat patients with **heart failure**.

So to sum all this up, you could inhibit the blood pressure raising effects of the RAA system by taking a drug or you could get more salt. And, you could take recombinant human Atrial Natriuretic Peptide to improve heart function, or you could get more salt. **Nonetheless,** we're recommended to restrict our salt down to a single teaspoon a day to avoid heart disease?

Now, I'm not saying you should consume as much salt as you possibly can, as mentioned earlier, 11 grams of salt give or take seems to be the optimal amount *for most people*. If you're exercising and sweating a lot, or you drink a lot of coffee or if you're lowering your insulin via a low carb or ketogenic diet, you may need more salt. While it's helpful to try and measure out how much you're getting per day, it's usually easier to just follow your built in salt intake regulator - Your sense of taste.

Most runners will notice that after sweating a lot during a long run, salty foods suddenly start to look really tasty. But When we think of salty foods, it's unhealthy foods - pretzels, potato chips, hot dogs, and processed foods. If you're craving those foods, you may just be craving their salt content. So, you should add as much high quality salt as tastes good on your next meal, or you could eat something like pickled olives, or just put a bit of salt and lemon in water and drink that.

Now, the advice “follow your craving” might sound odd considering that’s usually bad advice. People can come to crave narcotics, alcohol or sucrose. However, none of these substances are necessary for life and the optimal intake is very likely zero. Also, the more you consume these substances, the more you want them - in other words, it’s a positive feedback system. Salt on the other hand is a negative feedback system - the desire for salt decreases as the sodium content of the body rises.

This is why when you look at consumption trends, salt has stayed steady the past 50 years and table sugar, which recently has been proven to have addictive properties, continues to go up and up. As Mark Kurlansky points out in Salt: A World History “*Salt consumption is declining in most of the world. The average twentieth-century European consumed half as much salt as the average 19th century European.*” Salt consumption used to be much higher because salt had been the most effective food preservation technique at the time.

When salt is freely accessible, **people across many populations tend to consistently consume between 3 and 4 grams of sodium per day**. As this study points out, animals also keep their salt intake in a narrow range. I don’t think any farmer worries about their livestock licking a salt lick until they develop hypernatremia. It seems that the body will push us to acquire salt, but in accordance with our needs for the mineral.

A 1986 paper titled “Taste changes during pregnancy” shows pregnant women have a marked craving for salt. As the paper says, “*The data suggest that a physiological mechanism for increasing salt intake may develop during pregnancy.”* The paper even cites a case from 1691 where “*a pregnant woman consumed, by actual count, 1,400 salted herrings during her pregnancy.*”

A craving for salt is definitely something pregnant mothers don’t want to ignore. A study published in the Lancet in 1958 of more than two thousand

pregnant women found that women on a low salt diet compared to a high salt diet, caused more miscarriages, premature babies, stillbirths, edema and preeclampsia.

Salt is important to fetuses and children because it is required for optimal growth. A 1987 article titled "Sodium deprivation growth failure in the rat" found that low sodium diets decreased bone and muscle mass in rats. Another 1983 study found that low sodium left rats with smaller brains. But what about human studies? A study from the British Medical Journal concluded that "...*failure to provide [sufficient sodium to infants] may predispose to poor neurodevelopmental outcome in the second decade of life.*" Yet, the WHO guidelines specifically state that the low salt recommendations apply to all individuals, including pregnant or lactating women.

On the other side of the coin, there's another very important mineral that we need to be getting enough of.

Back in the day, life was just a bag filled with some ...stuff... and p**otassium** rich fluid. This bag was floating in a sodium rich fluid, the ocean. Of course this bag was a single celled organism. So the fluid inside the cell, the intracellular fluid was high in potassium. And the fluid outside the cell, the extracellular fluid was high in sodium. This balance was maintained during the upgrade to multicellular organisms.

We humans, while just a bit more complex, still maintain this balance. We have our own private salty ocean- the blood. In fact, *the watery portion of our blood, the plasma, has a concentration of salt and other ions that is remarkably similar to seawater.* And, the fluid inside our cells is still rich in potassium. Like sodium, potassium is also very important for the function of your cells.

So, if low sodium stresses the body, how did the idea that lowering salt intake is good for blood pressure come up? As James DiNicolantonio points out in the Salt Fix, blood pressure increase with a high salt intake can often be explained by a **potassium deficiency**.

For a while, Japan had been one of the strongest arguments against salt. “Japanese people were known to eat lots of salt, and while in general they had low rates of heart disease, they had a high rate of cardiovascular conditions, such as stroke and hypertension.”

Akita prefecture in specific had a high rate of hypertension and did consume a lot of salt - which of course became the prime suspect. Though researchers had already been pointing to factors unrelated to salt such as “deficiencies in the dietary life,” vitamin C deficiency, and the presence of cadmium in the intestines of the widely eaten river fish.

But, The Akita stroke rates were striking when compared with Aomori prefecture, which is adjacent to Akita, and was also consuming a high salt diet. The rate of death due to stroke was almost half in Aomori. And The average blood pressure in Aomori was relatively low (131.4/78.6 mmHg). What was happening here?

This 1962 paper by Naosuke Sasaki found a dose dependent relationship between daily apple intake and lowered blood pressure. While the data only accounts for none, one to two, or three apples per day, it shows that the more apples eaten, the lower the blood pressure. Apples are good source of potassium.

Dr. DiNicolantonio also shows that a similar effect was seen in “*Seventh-Day Adventist vegetarians, Seventh-Day Adventist omnivores, and Mormon omnivores. The daily intake of sodium in these groups was between 3,500 and 3,700 milligrams, slightly higher than what the average person in the United States consumes. However, the average blood pressure in the three groups was totally normal. Importantly, the*

potassium *intake was between 3,000 and 3,600 milligrams per day (almost twice as high as the average potassium intake in America).*"

In my other video on Salt I brought up how the average South Korean consumes at least twice as much sodium as the World Health Organization recommends yet has the lowest rates of coronary heart disease in the world. A September 2015 paper showed how the quartile groups **that consumed the most sodium had the lowest rates of hypertension, coronary heart disease and stroke**. But you'll also see that the potassium intake in these groups rose along with the sodium intake, probably because a lot of their sodium comes with vegetables, like in Kimchi. So did the increase in *potassium* or the increase in *sodium* improve their health? Or did the increase in *both* have a positive synergistic effect? In any case, increasing one's potassium intake is assuredly a better strategy for health than restricting your sodium intake below 3000 milligrams.

So the advice to be gleaned from the information about potassium is of course to eat more vegetables. And, by making them taste better with salt, you'll be inclined to eat more of them. After all, the word salad comes from the name of a delectable roman dish - herba salata. Salted Vegetables.