HIGH SCHOOL EDITION
Journal of Student Research
Volume 11 Issue 4 (2022)

Can Stress Cause Cancer?

Trisha Nataraj[1] and Jothsna Kethar[#]

[1] Gifted Gabber, USA
[#]Advisor

ABSTRACT

Stress is how people react when they feel under pressure or threatened. Stress typically occurs when people are in a situation that they do not feel they can manage or control. Today, more than ever, people of all ages and backgrounds experience stress which can have many negative effects on the body. Stress' effect on the body is harmful no matter what form it is in. However, the longer that stress is present in the body, the more harmful it becomes. Stress slowly weakens the immune system and the rest of the body's systems in different ways making the body more susceptible to certain diseases. This paper uses research done on stress' effect on the body and the health conditions people are more prone to develop if they are stressed, to identify if stress can cause someone to develop cancer. Along with this, the paper also uses research to describe the different effects the two different forms of stress have on the body and how chronic or long-term stress affects the body systems at a larger scale in comparison to acute or short-term stress. This emphasizes how dangerous stress can be if it remains in the body for a long period of time. Using this paper one can conclude that stress alone cannot directly cause a person to develop cancer, however, stress weakens the immune system and negatively affects the body making a person more prone to developing cancer. The aim of this paper is to identify how stress' effect on the body can lead to the development of cancer and cause cancer to spread in those who have it.

Introduction

Stress is one of the factors that people believe could lead to cancer. This is mainly due to the fact that stress targets specific body systems depending on the level of stress in a person's body. People respond to stress in different ways and there are different forms of stress. Depending on how a person copes with any form of stress they can negatively impact their health. Stress does not directly cause cancer; however stress weakens the immune system and negatively affects people's body systems making them more prone to developing cancer. If someone uses smoking as a coping mechanism for stress, there is a greater chance of them developing lung cancer. People can develop temporary stress that is caused by temporary obstacles. This type of stress is known as short term or acute stress. Acute stress is triggered by daily problems such as when someone is forced to give a speech in front of a large crowd. Acute stress tends to subside once the obstacle that caused that stress is overcome, meaning that acute stress only causes minor changes to someone's health. Anxiety, irritability, and poor concentration are all symptoms of acute stress, which mainly affects the cardiovascular and respiratory systems due to increased levels of adrenaline that produce an increased heart rate, quickened breathing rate, and higher blood pressure. Chronic stress or long-term stress is caused by constant obstacles in a person's life. Chronic stress can last weeks and even months and is usually triggered by ongoing problems such as having to care for a sick loved one. It can weaken a person's immune system making them more prone to developing diseases like cancer since stress decreases the body's lymphocytes. Lymphocytes are white blood cells that help fight off infections. Stress hormones inhibit a process which kills deceased cells and prevents them from spreading. Chronic stress increases the production of certain growth factors that increase a person's blood supply. This can speed the development of cancerous tumors. Since chronic stress causes certain growth factors in a person's

blood supply, chronic stress can help cancer spread and worsen people's health making them more prone to developing cancer. Therefore, chronic stress is more harmful towards the body than acute stress.

Different Forms of Stress

Stress comes in many forms but can be characterized as either acute or chronic stress. Stress can affect the body in many ways and the two forms of stress impact the body differently. Acute stress reaction occurs when a person experiences symptoms after a particularly stressful event. Symptoms of acute stress develop quickly and typically do not last long, making acute stress the most bearable form of stress. A downside to acute stress' short duration is the level of stress. Since acute stress is caused by a temporary issue, the amount of stress in anticipation for a stressful event is high. When faced with high levels of stress people tend to develop symptoms that display the high amounts of stress they are experiencing. Some examples of the symptoms caused by acute stress are irritability, anxiety, and poor concentration. A person with acute stress would experience irritability because they are so focused on the event that is causing them stress, that they do not have patience for anything else. Anxiety is caused by the constant thinking and worrying that a person who is anticipating a dreadful event would feel, and poor concentration would be the result of only focusing on that event. The high levels of stress cause an increased level of adrenaline in the body affecting the cardiovascular and respiratory systems by producing an increased heart rate, high blood pressure, and a quickened breathing rate. Another drawback to the high stress levels that acute stress causes is coping mechanisms that people develop to handle the amount of stress that they feel. People facing high amounts of stress will look for coping mechanisms that help them experience relief quickly and oftentimes the methods that help people cope with their stress quickly are unhealthy and increase a person's chance of developing cancer. Some examples of unhealthy coping mechanisms that a person may develop include smoking, drinking, and excessive eating. All these unhealthy coping mechanisms can contribute to the development of cancer and other health conditions. Smoking when faced with any minor obstacle will eventually lead to the development of lung cancer, this also applies to people who drink alcohol when they experience acute stress, as they can damage their liver. A damaged liver can weaken many of the body's organs making people more susceptible to developing diseases like cancer. Those who eat excessive amounts of food when experiencing acute stress are more likely to consume unhealthy foods that contain high levels of saturated fat that clogs the arteries and sugar which leads to obesity and poor cardiovascular health along with a myriad of other health conditions, including diabetes. Being overweight or having obesity greatly increases people's risk of developing certain types of cancer. These types of cancer include meningioma, multiple myeloma, and cancers of the thyroid. Overall, acute stress can cause high levels of stress, but due to its short duration does not impact people's risk of developing cancer on a large level, despite the body systems that it targets, and the unhealthy coping mechanisms people develop as a result of it. Chronic stress on the other hand, impacts many body systems. However, despite its long duration, chronic stress does not cause high levels of stress. Instead, chronic stress maintains a regular level of stress which due to the extended period that chronic stress affects the body, causes damaging effects. Chronic stress weakens the immune system by decreasing the body's lymphocytes. With a weakened immune system, the body becomes susceptible to a range of diseases. It can make people more prone to developing anything from a common cold to cancer. Having a weak immune system can have many other harmful effects on the body. A weakened immune system can result in frequent form of infections including bronchitis, sinus infections, and ear infections. Having a weakened immune system can also lead to blood disorders such as low platelet count or anemia. Digestive problems such as cramping, loss of appetite, and nausea can also occur because of a weakened immune system. Chronic stress also leads to the development of growth hormones that increase a person's blood supply and causes cancerous tumors to spread. Some forms of cancer that chronic stress can help spread include ovarian, breast, and colorectal cancer.

Acute stress does not weaken the body at the level that chronic stress does, making the effects of acute stress less harmful towards the body.

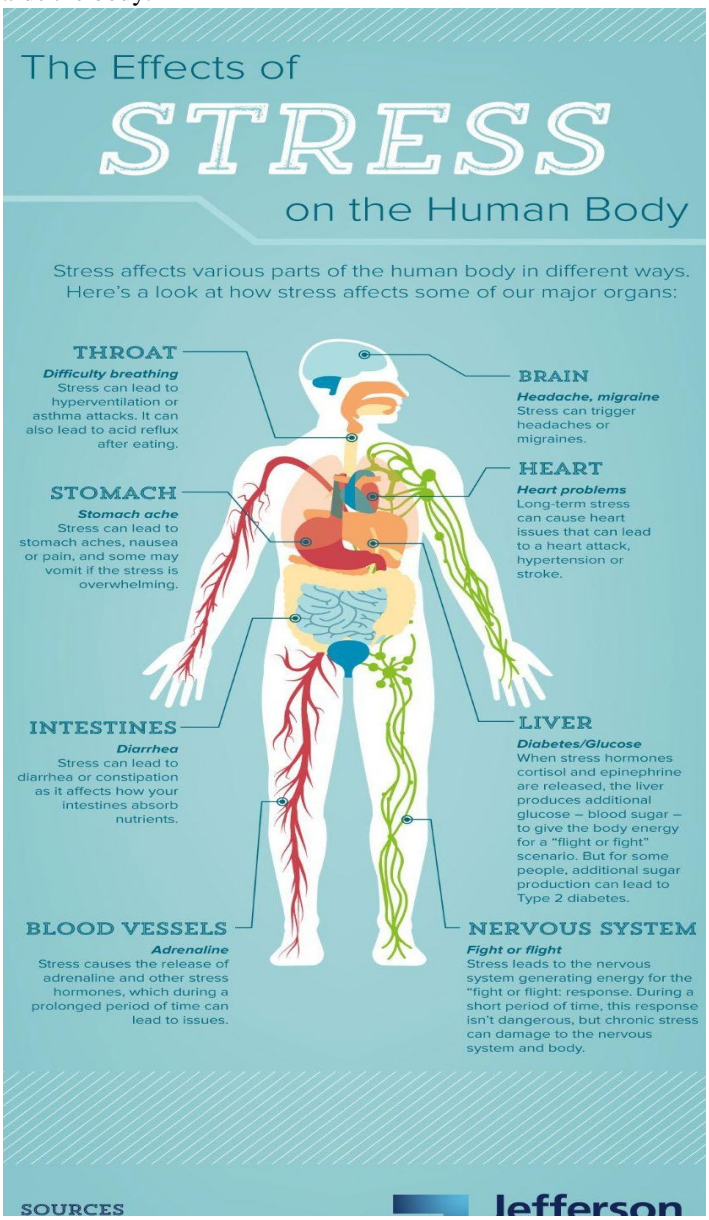

Figure 1, Stress Effect on the Body

Effects of Acute Stress

Acute stress' effect on the body, although minor, can have a lasting impact on many of the body's systems such as the respiratory and cardiovascular systems due to its sporadic appearance in a person's life. Acute stress is connected to the fight-or-flight response that the body has to threats. When the body feels threatened by a thing or an event, it either becomes defensive or chooses to avoid the thing that is making it feel threatened. The decision one must make between choosing to deal with their problem or avoiding it leads to the development of stress. The stress caused by the fight-or-flight response can cause a wide variety of mental and physical changes. When faced with an event that contributes to acute stress, every part of the body is forced to deal with all the aspects of the stress response. A part of the brain called the hypothalamus stimulates the pituitary gland.

When stimulated, the pituitary gland activates the thyroid and adrenal glands, which cause the bloodstream to flow with adrenaline, cortisone, and other stress hormones. The surge of these hormones affects the whole body. These hormones can lead to an increase in heart rate and cause blood pressure to rise. In response to this, breathing becomes faster, body muscles tighten, facial muscles constrict, pupils dilate, and hearing becomes sharper. These changes that occur in response to the stress hormones happen to make the body more aware and prepared for a similarly stressful experience. This can also cause sugar to be secreted into the bloodstream, blood to flow to the brain, muscles, and away from the stomach and intestines, the bowels and bladder relax, brain wave activity quickens, palms sweat, and hands and feet become colder as blood flows away from the skin to the brain and muscles. With this response, every body system is affected but only the cardiovascular and respiratory systems are greatly impacted enough to lead to the development of cancer. The increase in blood pressure that acute stress causes is linked to the development of many different forms of cancer. One of these forms of cancer is breast cancer. Women with high blood pressure have a 15% increased chance of developing breast cancer compared to women with normal blood pressure. Cancer and hypertension share many common risk factors. Hypertension can cause inflammation in the blood which contributes to the development of malignant or cancerous cells. The sugar that is secreted into the bloodstream during a stress response if occurring frequently can cause someone to develop diabetes. Abnormally high levels of insulin, which helps reduce blood sugar and can be found in people with type 2 diabetes can cause cancer. A buildup of blood sugar can also allow cancerous cells to grow. Cancerous cells use glucose as fuel to grow and expand. Many of the unhealthy coping mechanisms that people develop because of acute stress are responsible for causing cancer such as smoking, drinking, and excessive eating. However, not everyone that experiences acute stress uses a coping mechanism to deal with acute stress, meaning that not everyone who experiences acute stress is at risk of developing the cancers that could be caused by unhealthy coping mechanisms. On the other hand, respiratory illnesses caused as a result of acute stress can affect anyone who experiences acute stress and can lead to the development of certain cancers. Acute stress causes people to breathe faster, which can make breathing more difficult for people with asthma or lung disease such as emphysema. In addition, quickened breathing can lead to rapid breathing or hyperventilation, which can make people more prone to developing panic attacks. Hyperventilation can lead to a shortness of breath and the bodies of those who experience hyperventilation often will be weakened over time. Anything that weakens a person's body puts them at risk of developing a disease like cancer. The respiratory health of those who already have a lung disease like asthma deteriorates as a result of acute stress. Having asthma puts people at risk of developing lung cancer. Chronic inflammation caused by an intense case of asthma plays an important role in cancer development. Hyperventilation specifically can lead to respiratory alkalosis which typically occurs when high levels of carbon dioxide disrupt the blood's acid balance. Respiratory alkalosis like asthma, can lead to the development of lung cancer. Acute stress can only lead to the development of certain cancers since its short duration does not make much of an impact on the body. Chronic stress, however, can lead to the development of many cancers since chronic stress is long term. Chronic stress can affect nearly every body system, meaning that chronic stress is more likely to lead to the development of cancer.

Effects of Chronic Stress

Chronic stress' effect on the body is more harmful compared to acute stress' effect on the body for multiple reasons. Chronic stress lasts much longer than acute stress and can last for weeks to months since the issue that causes someone with chronic stress to feel stress is long term. People with chronic stress experience stress for extended periods of time, meaning that its constant appearance in the body impacts nearly all the body's systems and is more likely to cause someone to develop cancer than acute stress. Chronic stress starts off by weakening the body overall. Over time chronic stress causes a person to develop depression and depression weakens the body in many ways. One of the ways depression weakens the body is by causing fatigue, which makes it more

difficult for people to remain active. This can result in a lack of exercise which puts the body at risk of developing diseases that could lead to cancer, like obesity. Along with causing mental health conditions like depression, chronic stress also weakens the immune system. With a weakened immune system, it is possible for nearly any disease or infection to enter the body, including a disease as harmful as cancer. This includes viral infections such as the cold or the flu. The weakening of the body that occurs because of chronic stress has a domino effect. When a body is weakened, every system in the body becomes weak. A weakened body makes muscles tense which can lead to tension headaches, migraines, and other musculoskeletal conditions over time. With a weak immune system that makes people more prone to developing diseases, chronic stress can cause intense health conditions. Chronic stress can lead to many different problems including digestive problems, nervous system problems, and reproductive system problems. The stomach has hundreds of millions of neurons that function independently and that are in constant communication with the brain. Stress affects the communication between the brain and the stomach and can trigger pain, cause bloating, and allow other gut discomfort to be felt more easily. The gut is also inhabited by millions of bacteria which can influence its health and the brain's health. This impacts people's ability to think and affects emotions. Stress is associated with changes in gut bacteria which in turn can influence someone's mood. Therefore, the stomach's nerves and bacteria strongly influence the brain. These changes can increase people's risk of developing gastrointestinal issues. When stressed, a common coping mechanism is overeating. Consuming more or different foods, or an increase in the use of alcohol or tobacco, can result in heartburn or acid reflux. Stress or exhaustion can also increase the severity of regularly occurring heartburn pain. A rare case of spasms in the esophagus can be set off by intense stress and can be easily mistaken for a heart attack. Stress also may make swallowing foods difficult or increase the amount of air that is swallowed, which increases burping, gassiness, and bloating. Gastrointestinal issues in the esophagus and stomach can lead to the development of stomach cancer. Stomach cancer can affect the stomach and the area where the esophagus that carries the food that you swallow meets the stomach. Smoking, obesity, and gastroesophageal reflux disease all of which can occur as result of chronic stress leads to the development of stomach cancer. Chronic stress also plays a large part in affecting the nervous system. The nervous system has two parts: the central nervous system that deals with the brain and spinal cord and the peripheral nervous system consisting of the autonomic and somatic nervous systems. The body shifts its energy resources toward fighting off a life threat or fleeing from an enemy also known as the fight or flight response. When experienced repeatedly over time, this response can leave a lasting impact on the body. The central nervous system is particularly important in triggering stress responses, as it regulates the autonomic nervous system and plays a central role in interpreting contexts as potentially threatening. Chronic stress, which is when someone experiences stressors over a prolonged period, can result in a long-term drain on the body. As the autonomic nervous system continues to trigger physical reactions, it can weaken the body further. Continuous activation of the nervous system negatively affects other body systems. One of the body systems largely affected by the nervous system is the male reproductive system. The male reproductive system is influenced by the nervous system. In the male anatomy, the autonomic nervous system produces testosterone. Stress causes the body to release the hormone cortisol, which is produced by the adrenal glands. The hormone cortisol can affect the production of testosterone and cause testosterone levels in males to decrease. Low levels of testosterone have many negative effects and can lead to issues such as infertility in men. When stress affects the immune system, the body can become vulnerable to infection. However, low levels of testosterone give men a reduced risk of developing prostate cancer. In the male anatomy, infections to the testes and urethra are common and can occur because of chronic stress. Men that have infections in their urethra are more likely to develop urethral cancer, which occurs because of inflammation in the urethra. The female reproductive system is also largely affected by chronic stress. Stress can negatively impact a woman's ability to become pregnant, the health of her pregnancy, and her postpartum adjustment. Stress can affect fetal development during pregnancy and can lead to birth complications. With adjusting hormones, depression is the leading complication of postpartum. The excess stress caused by chronic stress can worsen postpartum depression and make recovery following birth more difficult. A female's body

uses up more of the hormone progesterone to manufacture the stress hormone cortisol, which results in an excess of estrogen. High levels of estrogen can lead to increased risk of breast and ovarian cancer in women. Unlike acute stress, chronic stress affects people's risk of developing cancer in several body systems while weakening the body more. Chronic stress is not only more likely to cause people to develop cancer, but chronic stress also makes it easier for certain cancers to metastasize or spread to other parts of the body.

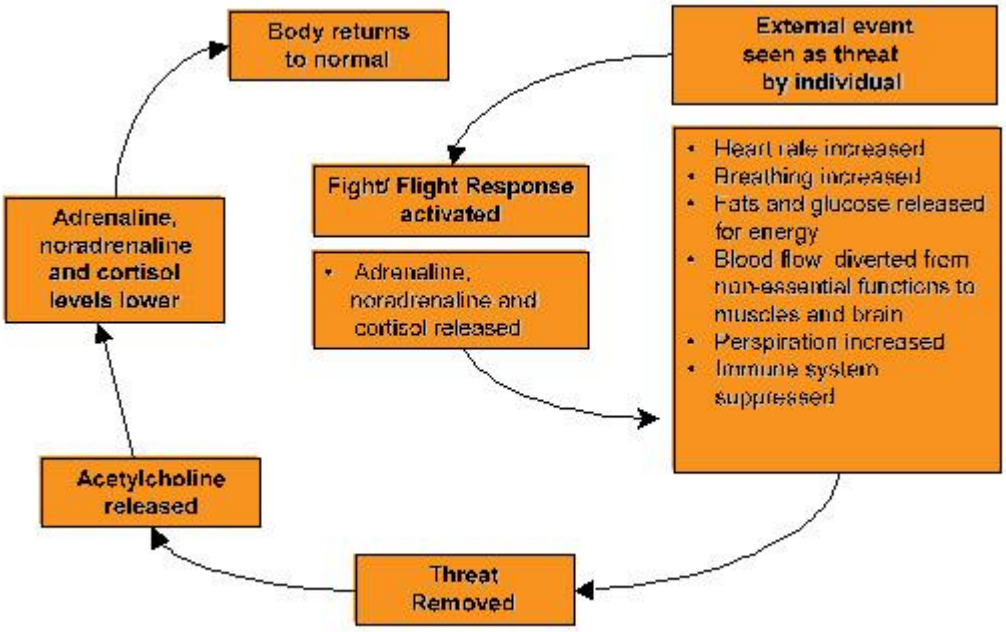

Figure 2. Fight or Flight Response

Stress and the Spreading of Cancer

Chronic stress has more than one impact on a person's risk of developing cancer. As well as weakening the body and immune system, chronic stress also affects many body systems and can even lead to the development of certain cancers in the body systems. Those who already have cancer are even more impacted by the effects of chronic stress, as it can also make it easier for certain cancers to metastasize. When people are diagnosed with cancer, people may experience an increase in stress which can eventually become chronic. Both chronic stress and cancer treatment such as chemotherapy weakens the body and immune system. For someone who already has cancer, stress can speed up the spread of cancer throughout the body. When the body becomes stressed, neurotransmitters like norepinephrine are released, which stimulate cancer cells. That stimulation can help cancer cells avoid death, expand, and adjust to new environments in the body, allowing them to grow in new places. Although chronic stress can speed up the spread of any cancer, chronic stress is more likely to speed up the spread of ovarian, colorectal, pancreatic, and breast cancers. With all types of cancer, chronic stress interferes with the body's ability to kill cancer cells that may be in the body. When it comes to ovarian cancer, chronic stress triggers a chain of molecular events that protect ovarian cells from destruction. Ovarian cancer patients face earlier mortality when a crucial protein activated by the hormones such as norepinephrine that are released when the body is stressed, is present at high levels in their tumors. Patients with depression caused by chronic stress have higher levels of this activated protein. This protein helps tumors grow and spread which is what makes ovarian cancer more likely to metastasize when a person experiences stress. While a protein causes ovarian cancer to metastasize, with colorectal or colon cancer, bacteria together with stress in

cells cause tumors to spread. Microbiota, a bacteria found in the colon plays a significant role in the programming and signaling of the central nervous system. Stress, especially chronic stress can shift gut bacteria in multiple regions and areas. With gut bacteria misplaced in the gut, key regulators of the stress response, such as members of the corticotropin-releasing-hormone (CRH) family of neuropeptides and receptors, are implicated in the regulation of chronic inflammation, one of the factors for tumor growth and disease progression. Stress accelerates the development of pancreatic cancer by triggering the release of fight or flight hormones, which play a key role in the development and spreading of cancer in the body. This effect occurs through the sympathetic nervous system, which releases hormones that give the body a surge of energy so that it can respond to perceived dangers. Pancreatic cancer is typically not detected early, making pancreatic cancer difficult to treat, especially since pancreatic cells do not respond as well to commonly used cancer therapies. This along with the affect chronic stress has on tumor development makes pancreatic cancer a more deadly form of cancer. Breast cancer on the other hand is not as deadly when detected early, even though chronic stress plays a key role in its ability to metastasize. In metastatic tumors, a type of receptor called "glucocorticoid receptors" are very active. These receptors bind to stress hormones, including cortisol. When these stress hormones are highly present, they activate glucocorticoid receptors. This triggers cancer cells' spread and supports their diversification. This is the main reason that cancers like breast cancer spread so easily. Despite chronic stress playing an active role in the development and spreading of certain cancers, there are certain cancers that stress does not affect the development of, because they can be found in genetics. Genes are pieces of DNA that are in control of how cells make proteins the body requires to function. Genes can affect a person's hair color, eye color, and height. They can also affect a person's chance of getting certain diseases like cancer. Genes can undergo abnormal changes called mutations. Mutations in a gene can affect how that gene functions. For example, mutations can stop a gene from working and keep a gene turned on all the time, even when it is not needed. Gene mutations can either be inherited or acquired and many family cancer syndromes are caused by inherited mutations in tumor suppressor genes. These are genes that normally keep cells under control by decreasing the number of times a cell divides, repairing DNA mistakes, or telling cells to die at the right time. With a mutation, these genes can cause cells to multiply uncontrollably and are responsible for the development of certain cancers including melanoma, leukemia, and prostate cancer. Regardless of whether a person has cancer in their genetics, chronic stress can still play a large part in the spreading of cancer.

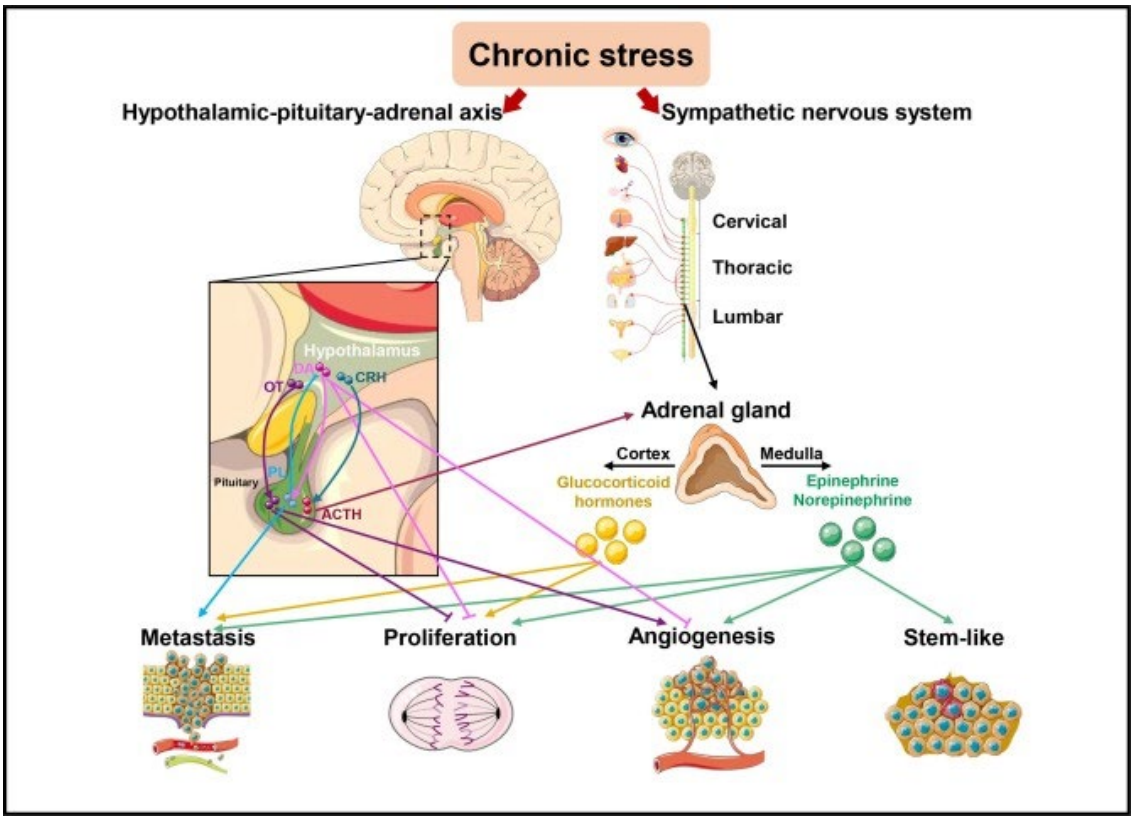

Figure 3. Chronic Stress Connection to Metastasis

Conclusion

Stress can impact many things including the diseases that one develops, such as cancer, making stress one of the most impactful factors to a person's health. Although stress may seem minor when a person is dealing with it, stress has a chain reaction within the body. One of the effects of stress can lead to another negative effect on the body which spreads from there, and if not handled properly can create irreversible damage. Not all stress is equally harmful, due to the fact that there are two forms of stress: acute and chronic stress. Acute stress is short-term stress, whereas chronic stress is long-term stress. The two forms of stress have different effects on the body because of the difference in duration and both are harmful. Since stress can have a negative effect on the body that can further affect the body and there are multiple forms of stress, stress alone cannot cause cancer. However, stress weakens the immune system and negatively affects people's body systems, making them more prone to developing cancer. Acute stress' symptoms develop quickly and do not last long, making acute stress more bearable. Since acute stress does not last long, the anticipation that someone experiences foreshadowing an upcoming event causes high levels of stress. To deal with the high levels of stress, people can develop unhealthy coping mechanisms such as smoking, which puts them at risk of developing cancer. Acute stress can affect any of the body systems, but mainly affects the cardiovascular and respiratory systems and increases people's chances of developing different cardiovascular and respiratory cancers due to the amount of stress hormones produced by the thyroid and adrenal glands triggered by the fight or flight response. This can affect the respiratory system by causing hyperventilation and a shortness of breath and the cardiovascular system by increasing heart rate and blood pressure. The fight or flight response, which is the response that a person experiences when faced with an event that causes them stress plays a large role as an effect of chronic stress as well. Chronic stress lasts longer so it can affect most body systems an equal amount unlike acute stress. Chronic stress starts off by weakening the body overall by weakening the immune system and causing fatigue. Then

slowly every body system weakens because of the spreading of chronic stress and causes problems that lead to the development of certain cancers. An example of a certain cancer that chronic stress can lead to is stomach cancer. By misplacing bacteria in the gut, key regulators of the stress response, such as members of the corticotropin-releasing-hormone (CRH) family of neuropeptides and receptors, are implicated in the regulation of chronic inflammation, one of the factors for tumor growth and disease progression. For someone who already has cancer, chronic stress can speed up the spread of cancer throughout the body. When the body becomes stressed, neurotransmitters like norepinephrine are released, which stimulate cancer cells. That stimulation can help cancer cells avoid death, expand, and adjust to new environments in the body, allowing them to grow in new places, which is why chronic stress can cause cancer to spread as well. Stress may impact the body in ways people have not discovered yet and can be responsible for other diseases as or more harmful than cancer. Specific events that people are unaware of can lead to stress and may even be harmful. If the specific events that trigger stress are found, people can find healthy ways to cope or overcome them so that they do not cause stress. Overall chronic stress is more harmful for the body due its longevity, which exemplifies that stress becomes more harmful the longer someone has it and emphasizes the importance of remaining calm. Even stress in anticipation of something temporary can become chronic which is why it is important that people identify that they are stressed early on so that they find healthy ways to cope with it, in order to reduce it. Some examples of healthy coping mechanisms include breathing exercises, mind-body exercises like yoga, talking to a trusted person or therapist, self-soothing exercises such as reassuring oneself, or attempting to identify what causes stress and figuring out how to fix it before it becomes a long-lasting problem. Avoiding unnecessary events that can lead to stress can help people to avoid stress and the negative implications that stress can lead to, including cancer.

Acknowledgments

I would like to thank Dr. Raj and Coach Jo for guiding me through the research paper process. I would like to thank Dr. Raj for giving me advice on my research paper and Coach Jo for supporting me through the research paper process, as well as teaching me how to format my research paper.

References

Can stress cause cancer? | Cancer Research UK
How stress affects cancer risk | MD Anderson Cancer Center
Psychological Stress and Cancer - NCI
Connection between chronic stress and cancer | City of Hope
Stress, Illness and the Immune System | Simply Psychology
Chronic Stress Promotes Cancer Development - PMC
Stress and Cancer | Surviving Cancer | Stanford Medicine
Can stress cause cancer? | World Cancer Research Fund
Study Suggests Link Between Stress, Cancer Returning - NCI
Cancer and Diabetes: More Connections Than You Think | City of Hope
How Stress Affects Heart Health | Heart and Vascular
Stress effects on the body
Family Cancer Syndromes