

Nutrient and Stress Management

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Abstract

Stress is a complex phenomenon and each individual has his/her own level of stress tolerance. Exposure to stressors results in a series of coordinated responses often referred to as 'stress responses' which are composed of series of reactions in the body including alterations in behaviour, autonomic function, secretion of multiple hormones and various physiological changes in the body. There are several ways to cope up with stress and one good solution is to eat stress fighting and reducing nutrient through food. A nutritious, well balanced diet has powerful stress reducing benefits that improve brain functioning, shore up immune function, lower blood pressure, improve the circulation, and reduce toxins from the body. Some specific nutrients play a very important role in reducing the levels of cortisol and adrenalin in the body and also the stress chemicals that activate fight and flight response. They are complex carbohydrates, proteins (tryptophan, phenylalanine and tyrosine, theanine) Vitamin C, Vitamin B, Magnesium, and Selenium. These nutrients play a very specific and important role in stress management. This review paper aims at eliciting the role of various nutrients and food items in stress reduction and management.

Keywords: Stress; Stressors; Stress busting food; Nutrients

Introduction

Stress is a diverse, complex phenomenon with various components initiating the triggering events and processing the brain to response. The responses may be emotional, biological or physical which varies from individual to individual because of both genetic and environmental factors and it often affects eating behaviour. The stress response is an adaptive mechanism. In most cases, the adaptation is physiologically appropriate but in others it can have pathological consequences. When stress levels are low, the body is often in a state of homeostasis: All body systems are operating smoothly to maintain equilibrium. Stressors trigger a "crisis-mode" physiological response, after which the body attempts to return to homeostasis by means of an adaptive response. The internal fight to restore homeostasis in the face of a stressor is known as the general adaptation syndrome, or GAS. The GAS has three distinct phases: alarm, resistance, and exhaustion. This leads to various physiological changes in the body. Stress is often described as a "disease of prolonged arousal" that leads to a cascade of negative health effects whose likelihood increases with on-going stress. Nearly all body systems become potential targets, and the long-term effects may be devastating.

Selye proposed a model in which stress has been seen as a cascade with a triggering event, a compensatory reaction and then the establishment of a new, homeostatic balance. Stress may be defined as "the response of a body to situations that pose demands, constraints or opportunities" and stressor is defined as "the stimulus that evokes a stress response" [1]. Stressor may be real or imagined, internal or external. The overall impact of a stressor will depend on its characteristics and the characteristics of those who have been affected. The perceived more than the absolute qualities of a stressor determine its potential impact. Tepas and Price [2] suggested that stress is commonly connected to the following concepts as adaptation, anxiety,

arousal, burnout, coping, exertion, exhaustion, exposure, fatigue, hardiness, mental load, repetitiveness, strain, stressor, and tension etc.

There is a tendency to identify triggering factors as situational (e.g. loneliness or tiredness), biological (premenstrual syndrome, seasonal depression, etc.) or self-induced (nicotine withdrawal, dieting, etc.), rather than as biological effects of endocrine factors on the immune system, the gastro-intestinal tract, metabolic function, behaviour or mood.

Stressors can be defined as conditions that endanger, or are perceived to endanger, the survival of an individual [3]. In general, these stressors can be grouped into three broad categories: (i) Psychological stressors based on a learned response to the threat of an impending adverse condition (fear, anxiety, exposure to a novel or uncontrollable environment); (ii) Stressors that consist of a physical stimulus and have a strong psychological component (pain, foot shock, immobilization); (iii) Stressors which challenge cardiovascular homeostasis (hemorrhage, orthostatic stress/upright tilt, exercise, heat exposure) [3]. Each individual has his/her own level of stress tolerance. When stress acts as a positive motivating force it is termed eustress. When it acts as a negative force it is termed distress. Stress only becomes a problem when it is chronic or severe. Stress plays a very crucial role in a multitude of negative human health behaviours [4]. Chronic stress tends to erode coping mechanisms.

Stress and Body Response

Exposure to stressors results in a series of coordinated responses organized to enhance the probability of survival. These coordinated responses, often referred to as 'stress responses' which are composed of series of reactions in the body which includes alterations in behaviour, autonomic function and the secretion of multiple hormones like adrenocorticotrophic hormone (ACTH) and cortisol/corticosterone, adrenal catecholamine, oxytocin, prolactin and renin etc. [3].

Some of the physiological changes associated with the stress response include: (i) Mobilization of energy to maintain brain and muscle function; (ii) Sharpened and focused attention on the perceived threat; (iii) Increased cerebral perfusion rates and local cerebral glucose utilization; (iv) Enhanced cardiovascular output and respiration, and redistribution of blood flow, increasing substrate and energy delivery to the brain and muscles; (v) Modulation of immune function; (vi) Inhibition of reproductive physiology and sexual behaviour; (vii) Decreased feeding and appetite [5,6].

The body has several backup dynamics to help ensure physical survival. Table 1 depicted various neuroendocrine pathways that are initiated to ensure the survival of human beings. This leads to release of various hormones that triggering by the neural aspects of the adrenal medulla that are released directly into the blood lasting minute to hour. A typical neuroendocrine response involves initially, within seconds, the increased secretion of catecholamine (epinephrine and norepinephrine) from the sympathetic nervous system and adrenal medulla, the release of CRF (corticotropin-releasing factor) and vasopressin from parvicellular neurons into the portal circulation and increased secretion of oxytocin from the neural lobe of the pituitary and the secretion of pituitary ACTH [3,6]. This response also involves, some seconds latter, a decreased secretion of pituitary gonadotropins and increased secretion of prolactin and growth hormone (in primates) from the anterior pituitary, increased secretion of renin from the kidneys and the pancreatic secretion of glucagon [6]. Several neuropeptides and neurotransmitters other than CRF also regulate the stress response in a coordinate way, each following a determined time course and specificity for a determined stressor.

| Effect | Reaction | Time |
|---------------------|---|-------------------------------|
| Immediate effect | Epinephrine (Ep) and norepinephrine (NEp) from the sympathetic nervous system | 2-3 seconds |
| Intermediate effect | Epinephrine (Ep) and norepinephrine (NEp) from adrenal medulla | 20-30 seconds |
| Prolonged effect | ACTH, Vasopressin, neuroendocrine pathway | Minutes, hours, days or weeks |

Source: Burges [7]

Table 1: Backup dynamics of body.

Many brain structures are involved in the response to psychologically and physically stressful stimuli. Figure 1 depicted the secretions of various hormones in response to stress to maintain homeostasis in the body. ACTH is the key regulator of glucocorticoids which play a key role in the termination of the stress response by exerting negative feedback at the levels of hypothalamus and pituitary. Glucocorticoids function is to help to generate glucose, through degeneration of protein during the process of gluconeogenesis in the liver as an energy source for both the brain and skeletal muscle. Cortisol is also involved in process of lipolysis for energy. Mineralocorticoids especially aldosterone, are secreted to maintain plasma volume and electrolyte balance.

Management of Stress through Nutrients

Management of stress may be a powerful tool for staying healthy. Researchers have investigated the relationships between stress and many different medical problems, such as cardiovascular diseases, diabetes [8], and cholesterol levels [9]. Because obesity is an underlying factor in these medical conditions, researchers [10-12] have often studied the role of stress in individuals' eating behaviours, such as the amount eaten and the types of foods consumed.

Stress creates greater physiological demands. More energy, oxygen, circulation, and therefore more metabolic cofactors are needed (e.g. vitamins and minerals). The irony of stress is that people suffering stress need a more nutritionally dense diet but often opt for comfort foods (like sugary and fatty foods) lacking in the necessary nutrients, consequently inducing a situation of nutrient depletion that further compromises the metabolic systems. Stress not only influences the choice of food of a person but also the quantity of the food eaten.

Role of specific nutrient in regulation of food intake, in the maintenance of homeostatic mechanisms and emotional processes is very dense. Serotonin (5-hydroxytryptamin or 5-HT) is synthesized from the dietary amino-acid tryptophan (TRP). Likewise, tyrosine is a precursor of noradrenaline (NA). Psychosocial and physical stress increases the rate of release of noradrenaline (NA) in both the periphery and the central nervous system hence more protein especially tyrosine is required. Likewise various other nutrients are required to reduce the levels of the stress chemicals (cortisol and adrenaline) that activate fight and flight response in the body. A detail description of various nutrients and role in coping with stress is mentioned as under:

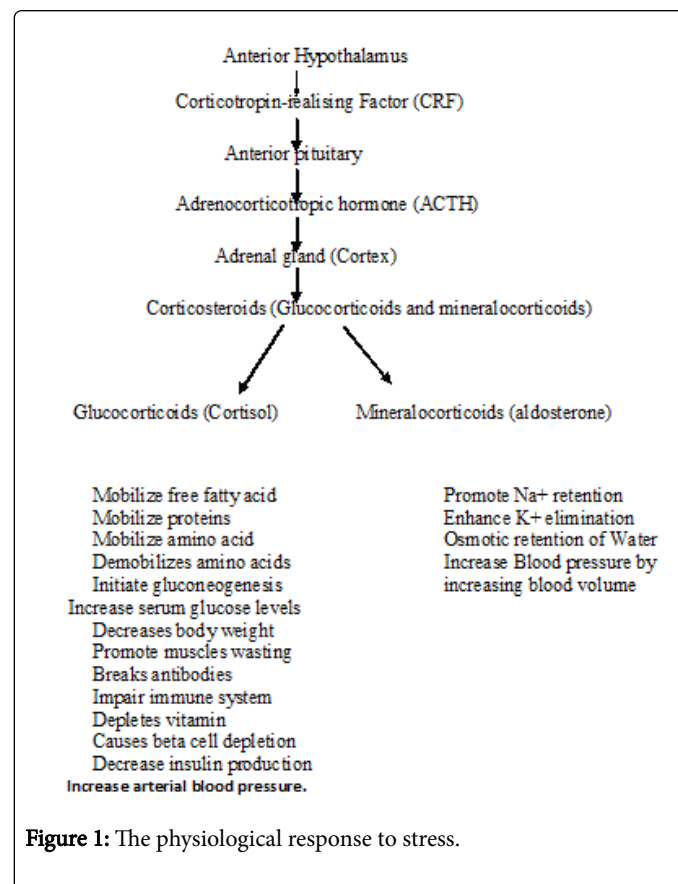


Figure 1: The physiological response to stress.

Complex carbohydrates-whole grains, vegetables and fruits will boost levels of serotonin, a chemical in the brain that makes us calm

Stabilizing blood pressure as a way to reduce stress. Serotonin (5-hydroxytryptamin or 5-HT) concentrations rise when TRP is directly administered or when the diet is rich in carbohydrate (CHO) and poor in protein (a CR-PP diet). Depletion of the precursor of serotonin synthesis, tryptophan, has been found to increased depressive mood in healthy subjects and subjects with a prior history of depressions [13]. Hence, increases in 5-HT may enhance the capacity to respond to stress and prevent further degeneration in terms of mood.

Complex carbohydrates also contributes to fibre. Fiber helps to maintain good stomach and digestive functioning. It make the food stay longer in stomach hence the more slowly the body absorbs carbohydrate, the more steadily serotonin flows.

Omega 3 fatty acids

The brain needs omega 3 fatty acids for the formation of healthy nerve cells. It has also been reported that omega 3 fatty acids are associated with a lower risk of depression [14]. Evidence from epidemiological, laboratory and clinical studies suggest that dietary lipids and other associated nutritional factors may influence vulnerability and outcome in depressive disorders [15]. Flaxseed, hemp, canola and walnut oils are all generally rich sources of the parent omega-3, alpha linolenic acid (ALA). Dietary ALA can be metabolized in the liver to the longer-chain omega-3 eicosapentaenoic (EPA) and docosahexaenoic acid (DHA). This conversion is limited in human beings, it is estimated that only 5-15% of ALA is ultimately converted to DHA [16] Stress compromise this conversion [17]. DHA (Docosahexaenoic acid) an essential component of the membrane of brain cells, enhances brain to utilize various chemicals and can turn on the genes that make serotonin. It is a good natural anti-depressant.

Proteins

Tryptophan: Tryptophan is an amino acid found in milk as well as in many proteins rich foods like whole grains. Serotonin is synthesized from tryptophan. Tryptophan works with vitamin B₆, niacin and magnesium to synthesize serotonin. If too little tryptophan is available for the brain, then it may limit the amount of serotonin. To make tryptophan-laden meals more effective, make them high in complex carbohydrates but medium to low in protein. Carbohydrate makes tryptophan more available in the brain but protein has the opposite effect.

Phenylalanine and tyrosine: Phenylalanine and tyrosine promote alertness, vitality and help in increasing the rate at which brain neurons produce antidepressants-dopamine and norepinephrine. Vitamin C is required to metabolize phenylalanine and tyrosine effectively. This show, rich source of vitamin C like citrus fruits may help in metabolism of phenylalanine and tyrosine. Tofu, dairy products, bananas, avocados, lima beans, pumpkin seeds, sesame seeds and almonds are the main sources of phenylalanine and tyrosine.

Theanine: Theanine has been studied for its potential ability to reduce mental and physical stress [18], improve cognition, and boost mood and cognitive performance in a synergistic manner with caffeine [19]. It relaxes the brain, thereby reducing stress and anxiety with tranquilizing effects. L-theanine significantly increases activity in the alpha frequency band which indicates that it relaxes the mind without

inducing drowsiness. However, this effect has only been established at higher doses than that typically found in a cup of black tea (approximately 20 mg). Tea is a good source of threonine.

Vitamin C: Both emotional and physical stress may affect a person's Vitamin C status. It can increase requirement for vitamin C to maintain normal blood levels. When stress depletes vitamin C levels in the body, it reduces the body's resistance to infection and disease and increases the likelihood of further stress. When vitamin C intake is increased, the harmful effects of the stress hormones are reduced and the body's ability to cope with the stress response improves. Vitamin C helps to recover more quickly from emotional and physical stress, which may otherwise weaken adrenal glands and increase fatigue. A randomized placebo-controlled study was carried out by Peters et al. [20] shows that marathon, runners receiving 1500 mg of vitamin C per day recovered normal cortisol levels more rapidly than those taking only 500 mg or the placebo. Because pumping out of cortisol stresses the adrenal glands, faster recovery means less fatigue.

Vitamin C is also believed to be a stress buster and reduces the stress by supporting the adrenal glands and allows a person to bounce back more quickly. Brody et al. [21] in a randomized, double blind, placebo-controlled trial on stress of public speaking concluded that those who received vitamin C supplements experienced less stage fright and showed a faster recovery of cortisol levels, indicating that the adrenal glands, which produce cortisol, the stress hormone, were functioning better.

Vitamin B: The majority of the B-vitamins function in the development and maintenance of the nervous system. The harmful effects of vitamin-B-deficiencies on the nervous system might increase the risk of developing stress-related symptoms such as irritability, lethargy and depression. They also help maintain regular blood-sugar levels to help keep your energy and mood stable. Among B-vitamins, most important is vitamin B₅ (pantothenic acid) which is often called anti-stress vitamin B₅ helps support the adrenal glands and improves coping mechanisms [22].

Some of the studies show that vitamin B₁₂ may ease the mood changes. Almonds are packed with B and E vitamins, which help boost the immune system, and walnuts and pistachios help lower blood pressure. One of the B vitamins is folic acid which is believed to relieve stress, anxiety, panic and even depression. Folic acid deficiencies have been found to contribute to mental illness. Folic acid is present in kidney beans, whole meal bread, broccoli, brussel sprouts, dark green cabbage, chicory, peanuts, peas, egg yolks and green leafy vegetables. Asparagus is high in B vitamins and folic acid.

Niacin, also referred to as nicotinamide, is not to be confused with nicotine from tobacco. A deficiency of niacin adversely affects tissue respiration and oxidation of glucose and results in the disease known as pellagra in humans. This is characterized by skin and mucous membrane disorders as well as depression and confusion. Pellagra can be cured by feeding niacin or by feeding the essential amino acid tryptophan from which niacin can be made in the body. Good sources of this vitamin are yeast, meat, fish, poultry, peanuts, legumes and whole grain cereals etc. [23].

Magnesium: Magnesium is needed for a variety of tasks such as muscle relaxation, fatty acid formation, making new cells and heartbeat regulation. Stress and magnesium are said to be interrelated. Both physical and psychological stress may stimulate the stress hormones. This, in turn, increases magnesium loss from the cells

(especially from the heart and other vital organs), stimulate urinary excretion and increase dietary requirements for the magnesium.

Selenium: Selenium is a mineral involved in the reactions which release energy from cells. Its deficiency may cause fatigue. Brazil nuts and also whole grains (if grown in selenium rich soil) are rich in selenium content. Adequate supply of vitamin E increases the effectiveness of selenium. Selenium have an impact on the function of the adrenal glands. Research shows that deficiencies of selenium can have a negative effect on adrenal function [24].

In order to consume the following nutrients, a person needs to adopt a particular defined of eating plan or diet. Following a strict plan and including the under given food will strengthen the body against stress and other illnesses that are thrust upon the body.

Stress-busting foods

Foods can elicit an emotional response when eaten. Foods can help tame stress in several ways. Comfort foods, like a bowl of warm oatmeal, boost levels of serotonin, a calming brain chemical. Other foods can cut levels of cortisol and adrenaline, stress hormones that take a toll on the body over time. A healthy diet can help counter the impact of stress by shoring up the immune system and lowering blood pressure. Few stresses busting food is as follows:

Oranges: Oranges are rich source of vitamin C stressed body are more prone to free radical formations. Vitamin C helps to keep free radicals in check and repairs the body. Basically, it helps protect the body from the cumulative effects of stress. Also vitamin C lowers blood pressure and stress hormone cortisol. Orange juice contains folic acid which helps to relieve stress. Drinking plenty of orange juice will help in production of dopamine in the body and make the person feel relaxation

Spinach: Spinach is considered to be a magic cocktail of all the greens. Being a rich source of magnesium (three cups of spinach supply about 40% of daily magnesium), it helps to lower stress level by keeping a person in a calm state and by preventing blood pressure from spiking [25]. Spinach is loaded with vitamin C (just a half-cup of raw spinach gives as close to 50% of recommended daily value (DV) for vitamin C), hence lowers blood pressure and stress hormone cortisol. Spinach is one of the richest food sources of folic acid (vitamin B₉).

Chocolate: Consuming dark chocolate reduces stress in two ways-its chemical impact and its emotional impact. Chocolate not only plays a role in fighting off free radicals, but it can affect both mind and mood. Chocolate is a complex material, possessing numerous compounds that act upon the brain, producing a sense of delight that no other substance can replicate. Cocoa beans are also one of the nature's most concentrated sources of theobromine, a molecular cousin of caffeine and theophylline, present in coffee and tea. Theobromine has been proved to be safe for human consumption. Cocoa liquor and cocoa butter are high in antioxidants, beneficial in lowering cholesterol level, boosting blood flow, reducing hypertension and also a good source of minerals. Phenyl ethyl amine (PEA) present in cocoa increases the activity of neurotransmitters. It also contains high level of epicatechin [26]. Cocoa beans contain nutrients essential to human mental and physical health such as iron, magnesium, potassium, phosphorus, zinc and polyphenols mainly flavonoids [27].

Chocolate's serotonin elevating activity helps to modify mood in positive way. Commonly known as a comfort food, research has now

promoted the status of chocolate as a psycho-active food. It has been discovered that in addition to anandamide that is present in ice-cream, chocolate is also loaded with positive neurotransmitters such as oleoethanolamine, N-linoleoylethanolamine etc. These chemicals produce active psychological effects in the consumer. Chocolates are also rich in tryptophan, which forms a rate-limiting step in the production of the mood-modulating neurotransmitter serotonin known to diminish anxiety. It has also found use in the treatment of pre-menstrual syndrome (PMS) due to its rich content of magnesium that lowers progesterone levels. Chocolate also contains amino acid gamma-aminobutyric acid (GABA) that is said to reduce anxiety [27].

Coffee: Epidemiological and experimental studies have shown positive effects of regular coffee-drinkers on various aspects of health, such as psychoactive responses (alertness, mood change etc.). Caffeine, an alkaloid, is the most widely consumed stimulant of coffee. According to numerous medical studies, caffeine is beneficial to overall health of human beings. It stimulates the central nervous system and flow of blood in the brain and increases the secretion of serotonin. Caffeine enhances alertness, facilitates thought formation and decreases fatigue. This alkaloid also improves mood, lifts the spirits and enhances both cardiovascular function and respiration. Taken by adults at a dose of 300 mg/day or less, caffeine is safe and beneficial for human health [28].

Blueberries: Blueberries are full of antioxidants and vitamin C. These nutrients are said to be great stress busters. The antioxidants fight the free radicals which adversely affect the memory. Vitamin C along with antioxidants helps to combat stress hormone cortisol. It is also the fiber present in blueberries which help to relieve stress. Also, the high fiber content keeps sugar level low and, therefore, stress is relieved.

Broccoli: One of the good mood foods is broccoli which has stress-relieving vitamin B₆. It also contains folic acid which is important in fighting depression.

Fish: Fish like Mackerel, Salmon, tuna sardines contains omega 3 fatty acids which boost the levels of serotonin, a neurotransmitter for good mood. It also has stress fighters like B₆ and B₁₂. These are important for the optimum functioning of the brain and enhance memory and mood.

Banana: Banana offers serious mood lifting power, with a combination of Vitamins B₆, A and C; fiber, tryptophan, potassium, phosphorus, iron and protein. The combination of natural sugars and fibers creates long-lasting energy to help in prevention of blood sugar imbalance. Carbohydrates aid in the absorption of tryptophan in the brain, Vitamin B₆ helps in conversion of tryptophan into mood-lifting serotonin and the potassium and iron work towards off fatigue by producing more energy. Iron in bananas exclusively is crucial to producing energy and fighting fatigue.

Walnuts: Walnuts have long been thought of as a 'brain food' because of their wrinkled, bi-lobed (brain like) appearance. They are an excellent source of omega 3 essential fatty acids and uridine. The combination of omega 3 fatty acids and uridine is thought to be a natural antidepressant. Walnuts also contain some other compounds like vitamin B₆, tryptophan, protein, and folic acid which contribute to stress releasing. Higher blood levels of omega 3 fatty acids have been linked with better mood and lower rates of depression [29].

Eggs: A hard-boiled egg is easy to make and easy to transport as snack food product. Full of high-quality protein and omega 3 fatty

acids (from the hens eating omega 3 fatty acids rich diet), eggs are also an excellent source of vitamin B₁₂ and a good source of vitamins B₂, B₅, and vitamin D. One boiled egg also contains more than 20 percent of the daily recommended amount of tryptophan hence considered a good stress busting food.

Tea: Green tea contains L-theanine a protein which relaxes the brain, thereby reducing stress and anxiety with tranquilizing effects. Consumption of 50 mg of L-theanine (equivalent to two-three cups of tea) has shown to stimulate the alpha-brain waves. The beta-brain waves are associated with reduction of tension. It also contains an active component, epigallocatechingallate (EGCG) which has been associated with reduced physical and mental fatigue.

Flax seeds: Flaxseeds (*Linum usitatissimum*) has a warm, earthy and subtly nutty flavour combined with an abundance of omega 3 fatty acids make it a good choice by vegetarians and a good brain foods. Flaxseeds are rich in alpha linolenic acid (ALA), an omega 3 fatty acid that is a precursor of eicosapentaenoic acid or EPA (omega 3 fatty acids found in fish oils). Therefore, along with ALA flaxseed provides several beneficial effects of EPA also. Flax seeds are the richest source of omega 3 fatty acids in the plant kingdom and are very promising functional food [30,31].

Whole grains: Whole grains are the rich source of carbohydrates. Carbohydrates are used as a comfort food because it makes a chemical (serotonin) that comforts a person. Carbohydrates cause the body to make insulin, which allows tryptophan (precursor of serotonin) to get into the brain [32]. Serotonin is considered to be the brain's natural "feel good" chemical and appetite suppressant [33]. Complex carbohydrates take longer time to get digested and, therefore, keep a person calm for longer period of time. Complex carbohydrates also stabilizing blood sugar level.

Turkey: Turkey contains precursor amino acid gets converted into dopamine in human body which elevates the mood and motivates the subjects. This acid is a good antidepressant and also helps us feel sharper and better.

Probiotics: Probiotics may be defined as "a viable mono or mixed culture of bacteria which, when applied to animal or man, beneficially affects the host by improving the properties of the indigenous flora [34]. There are numerous reasons for stress and its effect on the body is that it reduces the microflora in the gut and increases the growth of pathogenic bacteria. Probiotics exert their effect by inversely increasing the good bacteria, reducing the bad bacteria, improving barrier function, visceral senility and gut motility. Probiotic bacteria have the potential to alter brain neurochemistry and treat anxiety and depression-related disorders.

It was also contended by the researchers that regular feeding with *Lactobacillus* strain caused changes in the expression of receptors for the neurotransmitter GABA in the mouse brain. It has been demonstrated for the first time that potential probiotics have a direct effect on brain chemistry in normal situations [35]. Stress can cause various gastrointestinal discomforts like cramping, abdominal bloating, diarrhea or constipation. All of these symptoms can be ameliorated by the use of probiotics [36]. Two probiotic strains-*Lactobacillus acidophilus* and *Lactobacillus rhamnosus* have been found to prove beneficial for tackling stress [37-38].

Conclusion

Stress is a common problem that we all have to deal with in our lives, some more than others. There are many factors that bring stress upon the human body, in the surroundings and day to day life. The food a person consumes as part of their daily lifestyle can be utilized as a tool to overcome or to reduce the effect of stress on the body. Unhealthy eating patterns will only result in an increased level in stress, followed by further problems in the future if not resolved. One of the key ingredients to good health, and probably most important is having a well-balanced nutritional eating plan. A balanced nutrition plays an important role when we are under stress. When stress occurs, a well-balanced nutrition and good mood food will boost our resistance against the effects that stress brings upon the body.

Stress is going to happen at some point in a person's life and will most defiantly happen more than the once. However, as unavoidable as stress can sometimes be, it is always a choice. One can either let the body suffer from the effects of stress, or we can choose to do something about it. Thus to keep the body and mind healthy, every individual should know the stress management and nutrition play a key role in stress management.

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