

TAURINE

Taurine: protective effects on the cardiovascular system:

There is a substantial literature on Taurine and its role as a cardiovascular protector. Taurine contributes to many physiological functions of mammalian cells, such as osmoregulation, anti-inflammation, membrane stabilization, ion transport, and regulation of oxidative stress and mitochondrial protein synthesis. As regards the cardiovascular system in particular:

- Taurine decreases hypertension
- Taurine decreases platelet aggregation
- Taurine improves impairment of intimal thickening
- Taurine protects against and actually reduces arteriosclerosis
- Taurine improves vascular reactivity
- Taurine decreases oxidative stress in the vasculature
- Taurine decreases inflammation in the vasculature
- Taurine improves myocardial functional capacity
- Taurine improves myocardial oxygen consumption
- Taurine improves heart electrical activity

- Taurine is anti-atherogenic and anti-inflammatory, even in patients with heart failure, protecting them during exercise

- Taurine antagonizes the central action of excess angiotensin II. It thus lowers the blood pressure while at the same time reducing excess Sympathetic (catecholamine) stress.

- Taurine protects the heart against excess calcium binding, but without the extraordinary risks of calcium channel blockers (increased incidence of heart attacks, increased incidence of strokes, depression, fatigue, cognitive decline)

- Taurine prevents cardiac arrhythmias
- Taurine reduces excess vaso-constriction
- Taurine decreases the incidence of strokes
- Taurine lowers cholesterol
- Taurine possesses anti-thrombotic properties
- Taurine prevents angina.

Ahmadian M, et al. Taurine supplementation has anti-atherogenic and anti-inflammatory effects before and after incremental exercise in heart failure. Ther Adv Cardiovasc Dis. 2017.

Abebe W, et al. Role of Taurine in the vasculature: An overview of experimental and human studies. Am J Cardiovasc Dis. 2011.

Ahmadian M, et al. Taurine supplementation improves functional capacity, myocardial oxygen consumption, and electrical activity in heart failure. J Diet Suppl. 2017.

A tremendous amount of research since the early 1980s demonstrates Taurine's protective effect against heart attacks and strokes. Those benefits are largely the result of its effect on calcium and magnesium metabolism. Taurine helps keep calcium out of the myocardium and the smooth musculature of the arterial intima, and allows magnesium to fully exercise its biological role. But, beyond protecting against excess calcium and enhancing the effects of magnesium, Taurine also facilitates the elimination of excess cholesterol, and promotes vasodilation, and best of all actually decreases the size of atherosclerotic lesions. Taurine also protects against the damage associated with Insulin Resistance, the underlying cause of much hypertension, cardiovascular disease, abdominal obesity and Type II diabetes.

Obesity predisposes to cardiovascular and metabolic diseases. Taurine regulates glucose and lipid homeostasis and vascular function. Hypothalamic obese rats (induced by MSG) present massive abdominal fat deposition, hypertriglyceridemia, hyperinsulinemia, glucose intolerance, and high plasma levels of malondialdehyde (MDA), a lipid peroxidation marker. Taurine supplementation attenuates fat accumulation and prevents the increase in triglycerides as well as the increase in MDA. Taurine supplementation also reverses the deficient vasodilation response to acetylcholine in these MSG obese rats. Taurine supplementation also prevents the decreased tunica media thickness and the decreased lower aortic wall thickness/lumen diameter ratio and decreased total collagen content. It is concluded that the vascular protective actions of Taurine may be linked to several mechanisms --- including reduced lipid peroxidation and reduced cardiovascular risk factors such as abdominal fat and hypertriglyceridemia.

Leaovf, et al. Taurine supplementation prevents endothelial dysfunction and attenuates structural changes in aortas from hypothalamic obese rats. Eur J Nutr. 2018.

A World Health Organization multi-center epidemiological survey on diets and CVD risks and mortalities in 61 populations was done. Regarding Taurine, it was found that Taurine varies significantly and inversely with coronary heart disease mortality, inversely with Body Mass Index, inversely with systolic and diastolic blood pressure, inversely with total cholesterol, and inversely with atherogenic index. The benefits of Taurine on CVD risk were even higher in individuals who showed both substantial Taurine and magnesium levels. Another finding was that those individuals who are high sodium excretors with higher heart rate and whose blood pressure was significantly higher than those with lower heart rate showed significantly lower blood pressure if their Taurine

was adequate. It is concluded that Taurine may beneficially affect salt-sensitive blood pressure rise.

Yamori Y, et al. Taurine in health and diseases: Consistent evidence from experimental and epidemiological studies. J Biomed Sci. 2010.

Taurine regulates the mitochondrial respiratory chain. Its deficiency impairs cardiac mitochondrial respiratory function and causes cardiac myopathy.

Schaffer SW, et al. Impaired energy metabolism of the Taurine-deficient heart. Amino Acids. 2016.

In rodent models for stroke and abdominal aortic aneurysm formation Taurine is shown to have protective effects.

SUN Q, et al. Taurine supplementation lowers blood pressure and improves vascular function in pre-hypertension. Hypertension. 2016.

Schaffer SW, et al. Physiological roles of Taurine in heart and muscle. J Biomed SCI. 2010.

High-cholesterol-fed rats were used as a model to investigate the effects of Taurine supplementation on cholesterol metabolism. After two weeks of Taurine supplementation, the serum and hepatic cholesterol levels were reduced by 37% and 32%, respectively. These observations suggest that Taurine supplementation increases the synthesis and excretion of Taurine-conjugated bile acids and stimulates the catabolism of cholesterol to bile acid --- reducing cholesterol esterification and lipoprotein assembly for very low density lipoprotein secretion --- leading to reductions in serum and hepatic cholesterol levels.

Murakami S, et al. Taurine ameliorates cholesterol metabolism by stimulating bile acid production in high-cholesterol-fed rats. Clin Exp Pharmacol Physiol. 2016.

Kagaku, et al: Effect of Taurine on Cholesterol Metabolism, Chem. Absts. 103, 1985.

Rats in whom obesity was induced by a high fat polyunsaturated fatty acid (corn oil) diet were supplemented with Taurine. Taurine decreased total cholesterol and increased serum adiponectin.

You JS, et al. Positive correlation between serum Taurine and adiponectin levels in high-fat diet-induced obesity rats. Adv Exp Med Biol. 2013.

Mizushima S, et al. Effects of oral Taurine supplementation on lipids and Sympathetic nerve tone. Avv Exp Med Biol. 1996.

Hypothyroidism is accompanied by hyperlipidemia and oxidative stress and is associated with atherosclerosis. Paraonase activity and arylesterase enzyme activity is altered in association with both atherosclerosis and oxidative stress. In experimental hypothyroidism, it is found that Taurine supplementation increases paraonase and arylesterase activity, while decreasing tissue oxidative stress (measured by MDA level), as well as decreasing serum triglycerides.

Dirican M, et al. High-dose Taurine supplementation increases serum paraonase and arylesterase activities in experimental hypothyroidism. Clin Exp Pharmacol Physiol. 2007.

It is interesting to note that a form of heart disease that was the leading cause of death among cats was eliminated entirely as soon as cat food was supplemented with Taurine.

Azuma, J.: Taurine for Treatment of Congestive Heart Failure, Int. J. Cardi. 2:303-304, 1982.

An Australian study published in the Asia Pacific Journal of Clinical Nutrition 2001; 10(2):134-7, shows that Taurine is one of the key properties in fish that protects against cardiovascular disease. [Note: Taurine, not Fish Oil (which actually does catabolic, free radical oxidative damage to the brain and other tissues) is the protector against heart attacks, strokes, heart failure and angina pain.]

A large-scale study in Japan, drawing from 24 populations in 16 countries, reveals a strong inverse association between Taurine level and ischemic heart disease. This was published in Hypertension Research, 2001 JUL; 24(4):453-7.

Research at the University of South Alabama finds that congestive heart failure responds favorably to Taurine therapy. Their study is published in Amino Acids, 2000; 18(4):305-18.

A study published in Clinical and Experimental Pharmacology and Physiology, 2001 VOL 28, ISS 10, 809-815, describes mice bred for severe high cholesterol and atherosclerosis being fed Taurine for three months. Even though their (genetically predetermined) cholesterol levels were still significantly elevated after treatment, Taurine reduced the area of arterial lipid accumulation by an astounding 28%. There was also a decrease in the size of lesions in the aorta. The blood level of the oxidative stress marker TBARS was significantly decreased by the Taurine as well. Thus, while it has been long known that Taurine lowers elevated cholesterol in humans, it is now seen that

Taurine prevents the formation of atherosclerotic lesions independently of lowering blood cholesterol.

Quite impressive is the study published in the January 7, 2003 issue of Circulation showing that smokers initially have blood vessel diameters much smaller than non-smokers. Yet, after taking just 1.5 grams per day of Taurine for only five days, the smokers' blood vessel diameters increased to equal that of non-smokers.

Taurine in relation to optimal immune function:

Taurine (and serine) supplementation modulates the metabolic response to Tumor Necrosis Factor-alpha (TNF- α) in rats fed a low protein diet. ----- Plasma Taurine (and serine) decreases following trauma and in severe inflammatory disease. These changes may signify an increase in requirements for sulfur amino acids. Cysteine supplementation can restore the impaired ability of rats fed a low protein diet to increase hepatic zinc, glutathione, and protein concentrations in response to excess TNF- α . Since serine provides the carbon skeleton of cysteine and Taurine, the depression in lung glutathione due to TNF- α injection is lessened by Taurine. The absolute increase in ceruloplasmin in response to TNF- α is enhanced in rats fed an alanine-supplemented diet. Serine normalizes this response. It is observed that the effects of Taurine and serine on lung glutathione, plus a significant negative correlation between ceruloplasmin and liver and lung glutathione concentration in rats fed TNF- α , suggest that supplemental serine and Taurine may improve antioxidant defenses when dietary supplies of cysteine are low, but do not influence cysteine availability for normal response to TNF- α .

Obesity is generally associated with low-grade inflammation, which impairs insulin action. Taurine regulates glucose homeostasis and lipid metabolism and presents anti-inflammatory actions. Monosodium glutamate-induced obesity in rats was studied for its response to Taurine supplementation. The MSG rats were obese and hyperinsulinemic. Taurine supplementation reduced fat deposition and Taurine treatment decreased adiposity, and this effect was associated with normalization of circulating inflammatory cytokines TNF- α and IL-4.

Caetano LC, et al. Taurine supplementation regulates IK-Ba protein expression in adipose tissue and serum IL-4 and TNF- α concentrations in MSG obesity. Eur J Nutr. 2017.

No direct data exists on the influence of supranormal intakes of sulfur amino acids on immune function. However, 3 major products of sulfur amino acids --- glutathione (GSH), homocysteine, and Taurine, influence inflammatory aspects of the immune response in vitro and in vivo. Taurine and GSH ameliorate inflammation. Homocysteine has the opposite effect.

However, supplementation with the sulfur amino acids Cysteine and Methionine is not without potential problems. Cysteine supplementation (as NAC) can be problematic if not accompanied by adequate Glycine. NAC that is not absorbed intracellularly can actually create oxidative damage. All Glutathione is produced intracellularly and can only be produced when NAC and Glycine are supplemented at the same time. Each of those amino acids is easily absorbed into the cytosol, and then combined (with Glutamine) to synthesize intracellular GSH.

Methionine supplementation is almost always contraindicated. Gerontology research shows that Endogenous INFLAM-AGING, as driven by mTOR and the production of Senescent Cells, is provoked by intake of several amino acids, particularly Methionine, Leucine, and Arginine. Restriction of those amino acids becomes an important aspect to promote life extension beginning at age 33, and becoming imperative after age 43.

Methionine restriction attenuates insulin resistance, and stabilizes liver control of fat metabolism and bile acid flow, thereby decreasing any tendency to elevate cholesterol or triglycerides. In particular, Methionine restriction benefits insulin resistance and liver function compromised by dietary intake of polyunsaturated oils.

A biphasic relation between cellular GSH and CD4+ and CD8+ numbers occurs in healthy men. How changes in sulfur amino acid intake influence this phenomenon is unknown. In animals, high Taurine intake is anti-inflammatory.

A positive relation between plasma neopterin (a marker of Th1-type immune response) and homocysteine indicates that homocysteine may play a part in inflammatory aspects of Parkinson's Disease and aging. In vitro, homocysteine in concentrations seen following consumption of approximately 6 grams of L-methionine/day in adults, increases the interactions among T lymphocytes, monocytes, and endothelium. Whether a similar phenomenon occurs in vivo is unknown. A cautionary note about diets with L-methionine intake above approximately 1 gram/day is offered.

Delic D, et al. Loss of ability to self-heal malaria upon Taurine transporter depletion. Infect Immun. 2010.

Taurine accounts for more than 50% of free amino acids in immune cells. It also plays a crucial role in intestinal microorganism metabolism. Taurine improves T cell proliferation, promotes SCFA production, reduces endotoxins, and helps regulate intestinal ecology.

Taurine in relation to brain function and brain aging:

Consider that Taurine is a powerful protector against excitotoxic brain cell destruction in the hippocampus. Taurine protects against neuronal injury by preventing glutamate-induced elevation of intracellular free calcium.

The effect of Taurine supplementation on induced Alzheimer Disease cognitive impairments in Alzheimer model mice was tested. Taurine improved cognitive deficits in both Y-maze and passive avoidance tests. It was also found that Taurine directly bound to oligomeric amyloid. It is proposed that Taurine supplementation can ameliorate cognitive impairment by directly binding to amyloid.

Jang H, et al. Taurine directly binds to oligomeric amyloid- β and recovers cognitive deficits in Alzheimer model mice. Adv Exp Med Biol. 2017.

Taurine also protects the CNS from ammonia toxicity. Hepatic encephalopathy and hyperammonemia is a clinical complication associated with liver cirrhosis. Ammonia-induced brain injury is related to oxidative stress, locomotor activity dysfunction, and cognitive deficit which can lead to permanent brain injury. There is no promising pharmacological intervention against cirrhosis-associated brain injury, but Taurine may act as an antioxidant and is an excellent neuroprotective agent. It is found that Taurine supplementation alleviates brain tissue markers of oxidative stress and improves locomotor activity, suggesting that Taurine is a potential protective agent against cirrhosis-associated brain injury.

- To protect the brain from excess ammonia, recommended supplementation includes carnitine, Taurine, citrulline, and betaine.

Taurine is also an effective stabilizer of over-excitabile nerve tissue, and thus is very effective for seizure patients. (Seizures are virtually always an Anaerobic condition (and/or associated with a Systemic Alkalosis).)

- Quinolinic acid-induced seizures are prevented by: dopamine, nor-adrenaline, adrenaline, GABA, glycine, Taurine, proline, melatonin.
- CAUTION: Subsequent studies show that certain types of experimentally induced seizures are actually exacerbated by oral Taurine supplementation, even though Taurine when injected into the brain is protective. ----- Eppler B, et al. Kainic acid-induced seizures in Sprague-Dawley rats and the effect of dietary Taurine supplementation or deficiency. Amino Acids. 1999. ----- See also: --- Elidrissi A, et al. Prevention of epileptic seizures by Taurine. Adv Exp Med Biol. 2003.

Taurine also inhibits NMDA receptor-mediated nitric oxide synthesis, which protects against free radicals and extracellular accumulation of cyclic GMP arising from nitric oxide synthesis. Taurine also protects the CNS against nitric oxide-induced hydroxyl free radicals.

The importance of taurine in brain function is shown in rats, where it is present at high concentrations. Taurine displays a dose-dependent protection in a rat model of brain injury and protects against traumatic brain injury by increasing mitochondrial function and cerebral blood flow.

Wang Q, et al. Protective effects of Taurine in traumatic brain injury via mitochondria and cerebral blood flow. Amino Acids. 2016.

Heller-Stilb B, et al. Disruption of the Taurine transporter gene leads to retinal degeneration in mice. FASEB J. 2002.

Taurine inhibits the pain associated with neuropathy. Taurine is an inhibitory amino acid and is proposed as a nociceptive neuromodulator. A glycine receptor is postulated as a receptor by which Taurine exerts its function. It is the anterior cingulate cortex that is involved in the affective component of pain. Taurine injected into the anterior cingulate cortex yields significant neuropathic nociception relief --- with evidence that its pain relief is associated with glycine receptors.

Pellicer F, et al. Taurine in the anterior cingulate cortex diminishes neuropathic nociception: A possible interaction with the glycine (A) receptor. Eur J Pain. 2007.

Taurine in relation to muscle function and muscle aging:

Taurine has a cytoprotective role in exercise-induced muscle injury. ----- Taurine is present in high concentration in skeletal muscle and may play a role in cellular defenses against the oxidative stress and tissue damage resulting from intense exercise. Taurine supplementation significantly increases plasma glutamate in exercised rats. Exercise reduces plasma methionine, and Taurine prevents its decline. Taurine supplementation increases the muscle Taurine content significantly in all muscles except the soleus.

There is a relationship between Taurine and Beta alanine. Beta alanine decreases muscle Taurine content about 50% in all muscles examined. Lipid peroxidation (TBARS) is significantly increased by exercise in the extensor digitorum longus and gastrocnemius muscles, and both Taurine and beta alanine completely block the increase in TBARS in the extensor digitorum longus, but has no effect on the gastrocnemius. Muscle content of the cytosolic enzyme LDH is significantly decreased by exercise in the gastrocnemius muscle and this effect is attenuated by both Taurine and beta alanine. Muscle myeloperoxidase (MPO) is significantly elevated in the gastrocnemius muscle, and MPO activity is significantly increased by exercise in the liver, but both Taurine and beta alanine block this affect.

Running performance as assessed by a rating scale is improved by Taurine supplementation (and there is significant loss in body weight in beta alanine-treated rats 24 hours after exercise).

Taurine supplementation decreases oxidative stress in skeletal muscle after eccentric exercise. There is a delayed increase in arterial stiffness after eccentric exercise that is likely exacerbated by a concurrent delayed increase in circulating oxidative stress. Taurine has antioxidant action. It is shown that the delayed increase in arterial stiffness after eccentric exercise is likely affected by the exercise-induced oxidative stress, and that delayed increase in arterial stiffness is attenuated by Taurine supplementation.

----- Taurine supplementation in eccentrically exercised rats is found to decrease superoxide radical production, decrease creatine kinase, decrease lipoperoxidation, decrease carbonylation, and increase total thiol content in skeletal muscle, but it does not affect antioxidant enzyme activity. The study suggests that Taurine affects skeletal muscle contraction by decreasing oxidative stress in association with decreasing superoxide radical production.

Ra SG, et al. Taurine supplementation attenuates delayed increase in exercise-induced arterial stiffness. Appl Physiol Nutr Metab. 2016.

Taurine supplementation also improves endurance exercise performance.

Waldron M, et al. The effects of an oral Taurine dose and supplementation on endurance exercise performance in humans. Sports Med. 2018.

Taurine is critical as an osmolyte:

Taurine's function as an osmolyte is shown by studying the effect of its depletion on several organs.

- Taurine participates in controlling cell volume in a variety of cells.
- Taurine is a glycine receptor agonist, thus having a neuroprotective role in osmoregulation. The pituitary neuronal lobe is rich in taurine, which is essential for body fluid homeostasis.
- Taurine is the most osmotically active molecule in the brain.
- Taurine modulates calcium flux, thus affecting the contractile response in heart and muscle, and also modulates insulin levels, blood pressure, and membrane polarization.
- Taurine supplementation helps reduce the risk of diseases involving defective protein-folding by acting as a stabilizing chaperone for the proper folding of proteins as they come off the endoplasmic reticulum.

Yancy PH, et al. Water stress, osmolytes and protein. American Zoologist. 2001.

Taurine has powerful membrane stabilizing properties.

Welch WJ, et al. Influence of molecular and chemical chaperones on protein folding. Cell Stress Chaperones. 1996.

Numerous studies have shown the importance of the ability to transport Taurine, with damaging effects in several tissues if the transport system is defective. In rodent studies, those tissues include, brain, liver, eyes, skeletal muscles, immune cells, olfactory system, auditory system, and heart. Skeletal muscle aging is accelerated in Taurine deficiency.

Taurine in relation to Nutri-Spec Metabolic Imbalances:

Taurine is an amino acid-like substance (---technically, a sulfonic acid) containing a negative valence sulfur (sulfhydryl) functional group. In terms of NUTRI-SPEC Metabolic Imbalances, it is therefore anti-Anaerobic in its metabolic effect. It is also anti-Sympathetic in reversing the adverse effects of excess catecholamines. It also antagonizes the damage done by excess insulin (Insulin Resistance) in your Ketogenic and Anaerobic patients.

Taurine supplementation is thus a useful adjunct in balancing several of your NUTRI-SPEC Imbalances. These include:

- Electrolyte Stress Imbalance
- Anaerobic Imbalance
- Sympathetic Imbalance
- Ketogenic Imbalance

Conditions frequently found in patients who share one or more of these Imbalances include:

- fatigue
- high blood pressure
- cardiac arrhythmia
- cardiovascular disease
- high cholesterol
- seizures
- migraines

Taurine is synthesized in the pancreas, and many studies show its excellent therapeutic potential as a supplement against diabetes mellitus and related complications such as diabetic neuropathy, retinopathy, nephropathy, hematological dysfunctions, reproductive dysfunctions, liver and pancreas related complications, etc. Taurine exerts its therapeutic affects at least partly through its antioxidant and anti-inflammatory properties. Taurine, as well as some of its derivatives, show the benefits of Taurine supplementation in ameliorating diabetic complications, as well as the complications of diabetic Metabolic Syndrome.

Sarkar P, et al. Prophylactic role of Taurine and its derivatives against diabetes mellitus and its related complications. Food Chem Toxicol. 2017.

Taurine is involved in both the development of and the protection of the insulin apparatus. Taurine and insulin both have mutual stimulating actions with hypoglycemic properties. Taurine supplementation has a beneficial effect on platelet aggregation, as well as on neuropathy, cardiomyopathy, nephropathy,

and retinopathy. There is a role for Taurine in fetal development and in blocking the transfer of diabetes from diabetic mother to offspring.

Kim SJ, et al. Taurine-diabetes interaction: From involvement to protection. J Biol Regul Homeost Agents. 2007.

Taurine actually reverses the damage done by Insulin Resistance in your Ketogenic and Anaerobic patients with cardiovascular disease. There are studies estimating that perhaps in excess of 60% of all cardiovascular disease is associated with poor carbohydrate tolerance along with the associated Insulin Resistance.

Taurine parallels magnesium in its anti-Anaerobic, its anti-Ketogenic, and its anti-Sympathetic metabolic roles. Taurine also parallels magnesium in its role in reversing Electrolyte Stress.

In your Anaerobic and Ketogenic patients with Type II diabetes, Taurine will potentiate the activity of insulin, causing increased glucose clearance from the serum into the tissues.

Taurine has powerful membrane stabilizing properties. It has an anti-Anaerobic effect on membrane permeability to various ions. It is also an effective stabilizer of over-excitabile nerve tissue, and thus is very effective for seizure patients. (Seizures are virtually always an Anaerobic condition (and/or associated with a Systemic Alkalosis).)

- Quinolinic acid-induced seizures are prevented by: dopamine, nor-adrenaline, adrenaline, GABA, glycine, Taurine, proline, melatonin.

As an anti-Anaerobic sulfur donor, Taurine is effective in treatment of chemical sensitivities.

Low levels of Taurine are found in 64% of patients with Chronic Fatigue.

Taurine spares sulfur amino acids while providing an effective antioxidant.