

Meat the Truth

What you should know about the health effects of meat consumption

We don't need to eat meat. In fact, cutting meat out of your diet will protect your health because humans are not true carnivores and meat-eating has a wide range of detrimental health effects. The more meat you eat, the more serious the consequences can be but even small amounts can harm health.

Red, white and processed meat

The definition of white and red meat is based on the level of myoglobin – the iron-containing protein in muscle – giving meat its red and pink hues. White meat contains much less and that's why it has a paler colour. There are some overlaps, for example duck meat is darker in colour but still considered as white meat because it has less myoglobin than beef or pork.

Processed meat includes meat products that have been preserved by smoking, curing, salting or adding chemical preservatives such as sodium nitrite. In general, processed meat has had something done to it to extend its shelf life or change its taste. Most processed meats contain pork or beef, but they may also contain other red or white meats, offal or blood.

- **The following are usually classified as red meat:** beef and veal, mutton and lamb, pork, venison, goat, horse, burgers and mince (burgers and minced meats do not count as processed meat unless they have been preserved with salt or chemical additives)
- **These are usually considered white meat:** chicken, turkey, duck, goose, pheasant and rabbit
- **Processed meat includes:** sausages, bacon, ham, hot dogs, salami, frankfurters, tinned meat, pâtés, beef jerky, chorizo, pepperoni and corned beef

Now we know what's what, it's time to look at the health impacts of meat.

Heart disease and stroke

The term heart disease is often used instead of cardiovascular disease (CVD) and describes a chronic disease of the heart and blood vessels. The disease usually reduces blood flow to the heart, brain or body because of fat layers clogging the inside of your arteries, hardening and narrowing them (atherosclerosis). High cholesterol levels in your blood are the main problem, contributing building material for these fat layers, also called cholesterol plaques. Narrower arteries also mean higher blood pressure – that's often the first sign that something's wrong.

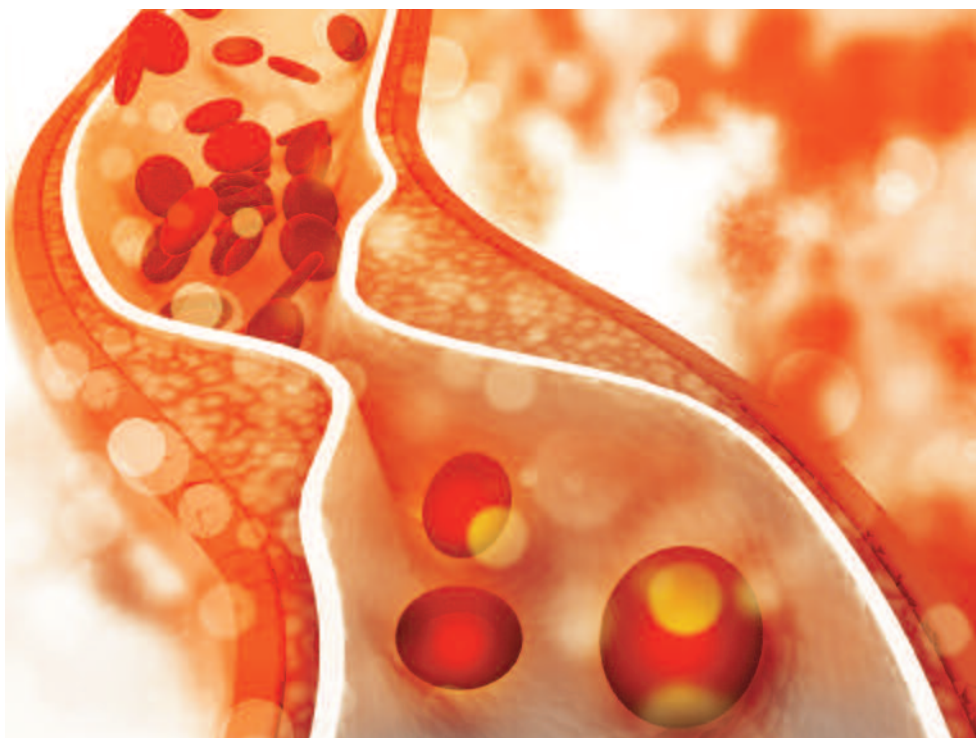
Heart attacks and strokes are mainly caused by blockages that cut off blood supply to the heart or the brain. A stroke can also be caused by a brain artery bursting.

Cholesterol

Beef, pork, poultry and lamb all contain high levels of fat, especially saturated fat, and eating a lot of saturated fat raises cholesterol levels in the blood. When a scientific team fed volunteers a diet high in red meat, then white meat and then no meat to compare the effects on cholesterol, their results were clear – both red and white meat increased cholesterol levels but a meat-free diet did not (Bergeron *et al.*, 2019). An analysis of studies focusing on the effect of swapping plant-based foods rich in protein for animal sources of protein found that the plant-based foods always had a cholesterol-lowering effect compared to animal products (Li *et al.*, 2017).

Processed meats such as sausages, salami and bacon contain even more saturated fats than red meat. The amount of fat in sausages often reaches 50 per cent of the weight or even more (Rohrmann *et al.*, 2013). Researchers from the Harvard School of Public Health examined 20 studies from 10 different countries and found a much higher risk of heart disease and stroke among people consuming the most processed meat (Micha *et al.*, 2010).

In Europe, the extensive EPIC study, including almost half a million people, revealed that people consuming more than 160 grams of processed meat daily had a 28 per cent increased risk of dying from heart disease compared to people eating hardly any (Rohrmann *et al.*, 2013).



Animal protein

Professor Colin T. Campbell – author of hundreds of scientific papers and co-author of *The China Study* (Campbell and Campbell, 2005) found that high intakes of animal protein went hand-in-hand with heart disease. In 2010, the Nurses' Health Study reported the same – higher intakes of red meat and whole-fat dairy products led to a higher risk of heart disease (Bernstein *et al.*, 2010). The study found that replacing a serving of meat with one of nuts lowered the risk of heart disease by 30 per cent. And a follow-up study found that the same swap lowered the risk of stroke by 17 per cent (Bernstein *et al.*, 2012).

Another study found that with each daily serving of red meat the risk of death from heart disease increased by 18 per cent and with each daily serving of processed meat, it increased by 21 per cent (Pan *et al.*, 2012). A large study of over 70,000 people found that those who ate the most plant protein and the least animal protein were 27 per cent less likely to die from heart disease in general, 28 per cent less likely to die from a heart attack and also 28 per cent less likely to die from stroke compared to people who ate the most animal protein (Budhathoki *et al.*, 2019).

Iron

There are two types of iron in the foods we eat – haem iron in red and processed meat, poultry and seafood, and non-haem iron in plants. Your body uses them differently – the absorption of haem iron from meat is unlimited, so you absorb it no matter what. That means high meat consumption can result in iron overload. On the other hand, your body only absorbs as much non-haem iron as it needs, so you cannot overload on plant iron.

Too much haem iron stimulates the formation of free radicals – dangerous molecules that can damage your DNA, blood vessel walls and increase the stickiness of cholesterol particles, making them more likely to form cholesterol plaques (Niki, 2011; Muñoz-Bravo *et al.*, 2013; Hunnicutt *et al.*, 2014; Kobayashi *et al.*, 2018). In a study from the Netherlands, people with a high haem iron intake from meat had a 65 per cent increase in heart disease risk (van der A *et al.*, 2004).

How to prevent heart disease

The American Heart Association's 2021 guidance on how to eat to protect your heart includes the advice to choose healthy sources of protein, such as pulses and nuts, while red and processed meat should be avoided (Lichtenstein *et al.*, 2021). Another important point they make is to avoid butter, lard, coconut and palm oil as these too are all high in saturated fat. They encourage everyone to eat more fruit, vegetables, wholegrains and unprocessed foods, and to limit sugar, salt and alcohol.

Compared to meat-eaters, vegans have a 63 per cent lower risk of high blood pressure (Pettersen *et al.*, 2012). If you already suffer from it, a healthy vegan diet can help you lower your blood pressure more effectively than other diets, including a vegetarian one (Lee *et al.*, 2020). Wholesome plant-based diets not only reduce the risk of heart disease and stroke, they also halt disease progression and may even reverse it (Esselstyn *et al.*, 2014; Freeman *et al.*, 2017; Kahleova *et al.*, 2018; Chiu *et al.*, 2020). Vegans and people who eat predominantly wholefood plant-based diets have lower blood pressure and cholesterol levels than all other diet groups and a much lower risk of heart disease – 25-57 per cent (Bradbury *et al.*, 2014; Le and Sabaté, 2014; Appleby and Key, 2016; Dinu *et al.*, 2017; Benatar and Stewart, 2018; Kahleova *et al.*, 2018; Korakas *et al.*, 2018; Matsumoto *et al.*, 2019).

Type 2 diabetes

Type 2 diabetes tends to develop later in life, largely due to an unhealthy lifestyle. However, more and more young people are being diagnosed and the link between the disease and the foods we eat is strong (Pan *et al.*, 2011). Several studies demonstrated that diets high in meat, fat and processed foods (Western style diets) drive your body to store tiny droplets of fat in your muscle and liver cells. When there's too much fat inside a cell, it stops being able to work properly and doesn't react to insulin (sugar-regulating hormone) correctly – resulting in insulin resistance, which is typical for type 2 diabetes (Sparks *et al.*, 2005; Morino *et al.*, 2006; Consitt *et al.*, 2009).



A large study of vegetarians and non-vegetarians showed that eating just one serving of meat per week significantly increased the risk of diabetes – by up to 74 per cent (Vang *et al.*, 2008). Many other studies examined the relationship between meat and type 2 diabetes and found that consumption of red meat increases the risk by 12-43 per cent, while processed meat increases the risk by 19-57 per cent (Micha *et al.*, 2010; Pan *et al.*, 2011; Steinbrecher *et al.*, 2011; Micha *et al.*, 2012; Zhang *et al.*, 2021).

One of the studies that found a connection between type 2 diabetes and red meat, processed meat and poultry listed the many components of meat that can contribute to the problem: saturated fats, animal protein, haem iron, sodium, nitrites and nitrosamines as well as other harmful substances (Feskens *et al.*, 2013). Of course, meat isn't the only culprit – high-fat dairy products, eggs, processed and junk foods, pies and cakes also play a role – but it's clear that meat plays a very important role in the development of type 2 diabetes.

How to reverse type 2 diabetes?

The good news is that a wholesome vegan diet can help prevent type 2 diabetes – in fact, vegans have up to 50 per cent lower risk (Appleby and Key, 2016; Salas-Salvadó *et al.*, 2019).

Even if you already have type 2 diabetes, a healthy vegan diet low in fat and high in wholefoods can help reverse it (Barnard *et al.*, 2009; Kahleova *et al.*, 2011; McMacken and Shah, 2017). In several studies, many patients were able to reduce their diabetes medication and some were able to discontinue it altogether, because they were no longer diabetic!



Cancer

There are many harmful components in meat that may cause cancer. Some people are more susceptible, some less but in general the more meat you eat, the bigger the risk.

Haem iron from meat – described above – is a risk factor not just for heart disease; it may also contribute to cancer by damaging your DNA. Then, there are three groups of compounds that are not present in raw meat but can form when meat is exposed to high temperatures or chemicals – during cooking, roasting, processing, smoking or preserving:

- N-nitroso-compounds (NOCs) form during meat preservation (in foods such as bacon or ham) and also in your gut during meat digestion – they have a strong cancer-causing effect (Joosen *et al.*, 2009; Abid *et al.*, 2014).





- Polycyclic aromatic hydrocarbons (PAHs) form during cooking meat over an open flame and have a strong potential to cause cancer (Phillips, 1999; Abid *et al.*, 2014).
- Heterocyclic amines (HCAs) form during cooking at high temperatures and also can cause cancer (Jägerstad and Skog, 1991; Abid *et al.*, 2014).

All these compounds, when consumed regularly over long periods of time, can lead to cancer. In 2015, the World Health Organisation (WHO) classified processed meat as carcinogenic (causing cancer) and red meat as probably carcinogenic (Bouvard *et al.*, 2015). According to their data, just 50 grams of processed meat (less than two slices of bacon) daily increases the risk of bowel cancer by 18 per cent and 100 grams daily of red meat increases the risk by 17 per cent. They also found links between red meat and pancreatic and prostate cancer, and processed meat and stomach cancer.

Other studies agree – even small amounts of red and processed meat can increase your risk of bowel, stomach, lung, kidney, bladder, pancreatic, thyroid, breast and prostate cancer (Grant, 2014; Wolk, 2017; Huang *et al.*, 2021). One of these studies also highlighted that while meat increases the risk of cancer, it doesn't offer any health benefits (Huang *et al.*, 2021).

Professor Colin T. Campbell believes that animal-based foods lead to an increased cancer risk while wholesome plant-based foods reduce the risk (Campbell and Campbell, 2005). According to other scientific studies, vegans have a 16-19 per cent lower risk (Tantamango-Bartley *et al.*, 2013; Key *et al.*, 2014).

Hormone-sensitive cancers – breast and prostate

Meat may also play a role in hormone-sensitive cancers. A large study of women found that postmenopausal women eating the most plant-based foods had a 30-63 per cent lower risk of breast cancer than women eating more meat and processed foods (Butler *et al.*, 2010). Another major study found that women who ate one-and-a-half servings of red meat daily had a 22 per cent increased risk of breast cancer compared with women who ate one serving a week (Farvid *et al.*, 2014). The authors calculated that replacing one daily serving of red meat with pulses (peas, beans and lentils) could lower breast cancer risk by 15 per cent among all women and 19 per cent among premenopausal women.

In a US study of men, weekly consumption of three or more servings of red meat, one-and-a-half or more servings of processed meat, one or more serving of grilled red meat and one or more serving of well-done red meat were each associated with a 50 per cent increased risk of developing advanced prostate cancer (John *et al.*, 2011).

Lung cancer

Smoking is a major risk factor for lung cancer but meat isn't far behind. A review of 33 studies from all over the world found that both red and processed meat consumption increased the risk of lung cancer (Xue *et al.*, 2014). With every 120 grams of red meat daily, the risk of lung cancer increased by 35 per cent and with every 50 grams of processed meat, the risk increased by 20 per cent. And another study found that a high intake of red meat increased the risk of lung cancer by 35 per cent (Yang *et al.*, 2012).

In a large study, a healthy diet based on vegetables, fruit and soya reduced lung cancer risk, while red and processed meat increased the risk (Sun *et al.*, 2016). A UK Biobank study supports this conclusion with the findings that each 50 grams of red meat daily increased the lung cancer risk by 36 per cent, while just 25 grams of processed meat upped the risk by 30 per cent (Wei *et al.*, 2021). On the other hand, fruit, vegetables, breakfast cereals and fibre had a protective effect and lowered the risk.

Bowel cancer

Bowel cancer (also called colorectal or colon cancer) is strongly linked to meat consumption because not only do meat residues (including their cancer-causing components) simply rot in the colon, they also feed toxic gut bacteria that can damage your gut wall and encourage cancer growth. Many studies agree – red and processed meat considerably increase the risk of bowel cancer (Bouvard *et al.*, 2015; Händel *et al.*, 2020; Cheng *et al.*, 2021; Veettil *et al.*, 2021).

Gout

Gout develops when uric acid crystals accumulate in the joints, causing chronic inflammation and irritation. During gout attacks, people experience intense joint pain. High levels of uric acid in the body have also been linked to kidney and heart disease – particularly to sudden events, such as heart attack or stroke, heart failure and atrial fibrillation (irregular heartbeat) (Maloberti *et al.*, 2021).

Your body produces uric acid when it breaks down purines and the richest purine sources by far are red meat and organ meats, such as liver or kidneys, and fish and shellfish. One review put it simply – seafood, red meat, alcohol and fructose syrup increase the risk, while soya and other pulses (peas, beans and lentils) and coffee lower the risk (Li *et al.*, 2018). This highlights that there's no need to avoid pulses as was once recommended because of their purine content – they contain much less than meat and offer a wide range of healthful nutrients.

According to the results of a comprehensive study, plant-based diets do not put you at risk of gout even if you consume purine-containing pulses, vegetables or mock-meat products – they simply aren't as high in purines as meat and fish (Jakše *et al.*, 2019). In fact, the study authors concluded that plant-based diets help to prevent gout and maintain healthy uric acid levels.

Obesity

Obesity is dangerous because it increases your risk of heart disease, high blood pressure, diabetes, arthritis, gallstones and some cancers. Being obese also weakens the immune system and slows down recovery time after an illness or injury.

Large studies of people with different eating habits found that people who ate the most meat were around 27-37 per cent more likely to be obese and 33 per cent more likely to have central

(around the waist) obesity compared to those eating the least (Wang and Beydoun, 2009; Vergnaud *et al.*, 2010; Rouhani *et al.*, 2014).

A comprehensive research study analysed data from 170 different countries and revealed that meat intake was directly linked to excess weight. In fact, meat turned out to be as bad as sugar for weight gain (You and Henneberg, 2016; You and Henneberg, 2016a). The likely reasons are that meat always contains considerable amounts of saturated fat but also that excess protein (that your body cannot immediately use) is also stored as fat. Recently, a large study on foods and the risk of obesity found that whole grains, vegetables, fruit and pulses help to prevent obesity while red meat, refined grains and sugar-sweetened drinks increase it (Schlesinger *et al.*, 2019).

When it comes to healthy weight loss, wholefood vegan diets are extremely effective at achieving and maintaining a healthy weight, even without portion restriction (Huang *et al.*, 2016; Turner-McGrievy *et al.*, 2015 and 2017; Najjar and Feresin, 2019).

Bone and kidney health

Meat is a rich source of protein and if you eat a lot of it, it can be a problem for your kidneys and bones. This is because meat protein contains more sulphur-containing amino acids than plant protein. These amino acids produce other acids when digested which puts a strain on your kidneys because it makes them work harder and requires calcium to neutralise them. If you have enough calcium in your diet, your bones won't be affected but if you have a low calcium intake, your body may use calcium from your bones to try and balance the acidic effects of animal protein (Weikert *et al.*, 2005; Mangano *et al.*, 2014).

In people with compromised kidney health, eating too many acid-forming foods may make matters worse, contribute to bone and also muscle loss (Dargent-Molina *et al.*, 2008; Frassetto and Sebastian, 2013; Scialla and Anderson, 2013). But even in healthy people, a meaty diet may undermine bone health. Several studies show that whether it's children or adults, a diet high in meat leads to worse bone health than a plant-based diet (Campbell and Tang, 2010; Zhang *et al.*, 2010; Dai *et al.*, 2014).

According to a major review by the US National Osteoporosis Foundation (Weaver *et al.*, 2016), bones need a good protein supply and plant protein does the job better than animal protein. The authors also concluded that fruit and vegetables have a positive effect on the bones, while carbonated (fizzy) drinks may have a negative effect. Lastly, they highlighted how important physical activity is for bone health, growth and development – bones need to be stimulated to be strong.



Food poisoning

Food poisoning is caused by eating contaminated food and usually results in vomiting and diarrhoea as your body attempts to get rid of the invaders – bacteria, viruses or toxins. Symptoms may also include fever, chills, stomach cramps, lack of energy and dizziness. In general, most people get better within a few days without treatment. Occasionally, food poisoning can lead to serious or long-term conditions or even death.

In most cases of food poisoning, the food is contaminated with bacteria such as *Salmonella*, *Campylobacter*, *Listeria* or *Escherichia coli*, or a virus such as norovirus. Most cases of food poisoning are caused by animal products (meat, poultry, eggs, fish and dairy) as plants tend not to carry the types of bacteria that cause food poisoning in humans. If plant foods do cause food poisoning it is generally because they have been contaminated with animal faeces, human sewage or handled with unwashed hands during preparation.

According to a large study of food contamination in the UK, Canada, Denmark, the Netherlands, the US and the EU (Lund *et al.*, 2015), this is how much meat carries bacteria causing food poisoning:





- *Campylobacter* – 40-90 per cent of poultry; up to 40 per cent of red meat
- *Clostridium perfringens* – 40-50 per cent of beef and lamb, up to 20 per cent of poultry
- *Salmonella* – up to 40 per cent of poultry, up to 20 per cent of pork, beef and lamb each
- *E. coli* O157 – 40-70 per cent of beef and lamb
- *Listeria* – up to 50 per cent of red meat, up to 20 per cent of other meats

Campylobacter is a major cause of food poisoning in Europe and the world. The main source of infection is poultry, followed by beef, pork and sometimes game (Brown *et al.*, 2014; Lund *et al.* 2015; Chlebicz and Slizewska, 2018).

E. coli is found almost everywhere but only some strains cause food poisoning. Major sources of the tummy bug infection are beef, dairy and cattle faeces (Larsen *et al.*, 2014; Stein and Katz, 2017).

Listeria is another dangerous bacterium causing more than just food poisoning – it's fatal for 20-30 per cent of people who get the infection. The foods responsible are predominantly meat products, milk, butter, soft cheese, cottage cheese, fish and shellfish (Larsen *et al.*, 2014; Chlebicz and Slizewska, 2018).

Salmonella is a notorious bacterium most commonly linked to eggs. Even though most UK egg producers are now required to vaccinate their flocks, it's still found at chicken farms. Chickens raised for meat may carry the disease, as well as pigs and fish (Larsen *et al.*, 2014).

Norovirus, notorious for causing severe cases of vomiting and diarrhoea, can usually be traced to raw or undercooked meat and seafood, ready-to-eat products and fruit and vegetables (Tuan Zainazor *et al.*, 2010). The latter is usually due to animal manure used as fertiliser or irrigation water contaminated with animal faeces (Tuan Zainazor *et al.*, 2010).

Antibiotic-resistant bacteria

Factory farms are the ideal breeding grounds for deadly bacteria that are constantly evolving. This is why some farmers use antibiotics not just to treat sick animals but also to prevent the spread of diseases. Shockingly, it's estimated that worldwide, 80 per cent of all antibiotics are used on livestock (Haskell *et al.*, 2018). This massive use of antibiotics has a dangerous side-effect – bacteria develop antibiotic-resistance. It means that if you're infected by antibiotic-resistant bacteria, your illness will be difficult or even impossible to treat with the medicines we have.

One example is MRSA – an antibiotic-resistant type of *Staphylococcus aureus*. MRSA first appeared in Belgian cattle, later at Dutch pig farms and has since spread to farms across Europe, North and South America, Asia and North Africa. It is found in pigs, cattle, horses, poultry, sheep, rabbits, cats, dogs and many species of wild animals – and of course people too (Aires-de-Sousa, 2017). A recent study confirmed that MRSA is found at farms that routinely use antibiotics (Haskell *et al.*, 2018).

Once bacteria develop antibiotic-resistance, they can cause serious health issues, such as life-threatening sepsis. It develops when bacteria get into the blood and do not respond to antibiotic treatment. In the UK, 46,000 people die of sepsis every year (Antibiotic Research UK, 2019). Currently, around 700,000 global deaths are caused by antibiotic-resistant superbugs each year, this number could rise to 10 million per year by 2050 if no action is taken to curb the overuse of antibiotics (O'Neill, 2016).

The overuse of antibiotics on livestock and fish farms and its dangerous consequences are well documented but with the sheer numbers of farmed animals, it's difficult to control disease any other way (Mathew *et al.*, 2007; Manyi-Loh *et al.*, 2018). It seems our only option to limit antibiotic resistance and its threats is by not eating animals.

Eating meat is harming your health but it's also unsustainable as animal farms pose a major environmental problem and, of course, it's cruel to the animals too. Living meat-free brings so many benefits that it should be a fundamental public health recommendation.

References

- Abid Z *et al.* 2014. Meat, dairy, and cancer. *American Journal of Clinical Nutrition*. 100 Suppl 1:386S-935.
- Aires-de-Sousa M. 2017. Methicillin-resistant *Staphylococcus aureus* among animals: current overview. *Clinical Microbiology and Infection*. 23 (6) 373–380.s
- Al-Shaar L *et al.* 2020. Red meat intake and risk of coronary heart disease among US men: prospective cohort study. *BMJ*. 371:m4141.
- Antibiotic Research UK. 2019. About antibiotic resistance. Available at: antibioticresearch.org.uk/about-antibiotic-resistance/
- Appleby PN and Key TJ. 2016. The long-term health of vegetarians and vegans. *Proceedings of the Nutrition Society*. 75 (3) 287-293.
- Barnard ND *et al.* 2009. A low-fat vegan diet and conventional diabetes diet in the treatment of type 2 diabetes: a randomized, controlled, 74-wk clinical trial. *American Journal of Clinical Nutrition*. 89 (5) 1588S-1596S.
- Benatar JR and Stewart RAH. 2018. Cardiometabolic risk factors in vegans; A meta-analysis of observational studies. *PLoS One*. 13 (12) e0209086.
- Bergeron N *et al.* 2019. Effects of red meat, white meat, and nonmeat protein sources on atherogenic lipoprotein measures in the context of low compared with high saturated fat intake: a randomized controlled trial. *American Journal of Clinical Nutrition*. 110 (1) 24-33.
- Bernstein AM *et al.* 2010. Major dietary protein sources and risk of coronary heart disease in women. *Circulation*. 122 (9) 876-883.
- Bernstein AM *et al.* 2012. Dietary protein sources and the risk of stroke in men and women. *Stroke*. 43 (3) 637-644.
- Bouvard V *et al.*, International Agency for Research on Cancer Monograph Working Group. 2015. Carcinogenicity of consumption of red and processed meat. *The Lancet Oncology*. 16(16) 1599-600.
- Bradbury KE *et al.* 2014. Serum concentrations of cholesterol, apolipoprotein A-I and apolipoprotein B in a total of 1694 meat-eaters, fish-eaters, vegetarians and vegans. *European Journal of Clinical Nutrition*. 68 (2) 178-183.
- Brown HL, *et al.* 2014. Chicken juice enhances surface attachment and biofilm formation of *Campylobacter jejuni*. *Applied Environmental Microbiology*. 80 (22) 7053-7060.
- Budhathoki S *et al.* 2019. Association of animal and plant protein intake with all-cause and cause-specific mortality in a Japanese cohort. *JAMA International Medicine*. 179 (11) 1509-1518.
- Butler LM *et al.* 2010. A vegetable-fruit-soy dietary pattern protects against breast cancer among postmenopausal Singapore Chinese women. *American Journal of Clinical Nutrition*. 91 (4) 1013-1019.
- Campbell TC and Campbell TM II. 2005. *The China Study*. Dallas, Texas, USA: BenBella Books.
- Campbell WW and Tang M. 2010. Protein intake, weight loss, and bone mineral density in postmenopausal women. *Journals of Gerontology. Series A Biological Sciences and Medical Sciences*. 65 (10) 1115-1122.
- Cheng T *et al.* 2021. Diet derived polycyclic aromatic hydrocarbons and its pathogenic roles in colorectal carcinogenesis. *Critical Reviews in Oncology/Hematology*. 168, 103522.
- Chiu THT *et al.* 2020. Vegetarian diet and incidence of total, ischemic, and hemorrhagic stroke in 2 cohorts in Taiwan. *Neurology*. 94 (11) e1112-e1121.
- Chlebicz A and Śliżewska K. 2018. *Campylobacteriosis, Salmonellosis, Yersiniosis, and Listeriosis as Zoonotic Foodborne Diseases: A Review. International Journal of Environmental Research and Public Health*. 15 (5) 863.
- Consitt LA *et al.* 2009. Intramuscular lipid metabolism, insulin action, and obesity. *IUBMB Life*. 61 (1) 47-55.
- Crowe FL *et al.* 2013. Risk of hospitalization or death from ischemic heart disease among British vegetarians and non-vegetarians: results from the EPIC-Oxford cohort study. *American Journal of Clinical Nutrition*. 97 (3) 597-603.
- Dai Z *et al.* 2014. Adherence to a vegetable-fruit-soy dietary pattern or the Alternative Healthy Eating Index is associated with lower hip fracture risk among Singapore Chinese. *Journal of Nutrition*. 144 (4) 511-518.
- Dargent-Molina P *et al.* 2008. Proteins, dietary acid load, and calcium and risk of postmenopausal fractures in the E3N French women prospective study. *Journal of Bone and Mineral Research*. 23 (12) 1915-1922.
- Dinu M *et al.* 2017. Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*. 57 (17) 3640-3649.
- Esselstyn CB Jr *et al.* 2014. A way to reverse CAD?. *Journal of Family Practice*. 63 (7) 356-364b.
- Farvid MS *et al.* 2014. Dietary protein sources in early adulthood and breast cancer incidence: prospective cohort study. *British Medical Journal*. 348 g3437.
- Feskens EJ *et al.* 2013. Meat consumption, diabetes, and its complications. *Current Diabetes Reports*. 13 (2) 298-306.
- Frassetto L and Sebastian A. 2013. Commentary to accompany the paper entitled 'nutritional disturbance in acid-base balance and osteoporosis: a hypothesis that disregards the essential homeostatic role of the kidney', by Jean-Philippe Bonjour. *British Journal of Nutrition*. 110 (11) 1935-1937.
- Freeman AM *et al.* 2018. A Clinician's Guide for Trending Cardiovascular Nutrition Controversies: Part II. *Journal of the American College of Cardiology*. 75 (5) 553-568.
- Grant WB. 2014. A Multicountry Ecological Study of Cancer Incidence Rates in 2008 with Respect to Various Risk-Modifying Factors. *Nutrients*. 6 (1) 163-189.
- Händel MN *et al.* 2020. Processed meat intake and incidence of colorectal cancer: a systematic review and meta-analysis of prospective observational studies. *European Journal of Clinical Nutrition*. 74 (8) 1132-1148.
- Haskell KJ *et al.* 2018. Antibiotic resistance is lower in *Staphylococcus aureus* isolated from antibiotic-free raw meat as compared to conventional raw meat. *PLoS One*. 13 (12) e0206712.
- Hooper L *et al.* 2012. Reduced or modified dietary fat for preventing cardiovascular disease. *Cochrane Database of Systematic Reviews*. 5 CD002137.
- Huang Y *et al.* 2021. Red and processed meat consumption and cancer outcomes: Umbrella review. *Food Chemistry*. 356 129697.
- Huang RY *et al.* 2016. Vegetarian diets and weight reduction: a meta-analysis of randomized controlled trials. *Journal of General Internal Medicine*. 31(1) 109-16.
- Hunnicut J *et al.* 2014. Dietary iron intake and body iron stores are associated with risk of coronary heart disease in a meta-analysis of prospective cohort studies. *Journal of Nutrition*. 144 (3) 359-366.
- Jägerstad M and Skog K. 1991. Formation of meat mutagens. *Advances in Experimental Medicine and Biology*. 289 83-105.
- Jakše B *et al.* 2019. Uric acid and plant-based nutrition. *Nutrients*. 11 (8) 1736.
- John EM *et al.* 2011. Meat consumption, cooking practices, meat mutagens, and risk of prostate cancer. *Nutrition and Cancer*. 63 (4) 525-537.
- Joosen AM *et al.* 2009. Effect of processed and red meat on endogenous nitrosation and DNA damage. *Carcinogenesis*. 30 1402-1407.
- Kahleova H *et al.* 2018. A plant-based dietary intervention improves beta-cell function and insulin resistance in overweight adults: a 16-week randomized clinical trial. *Nutrients*. 10 (2) 189.
- Key TJ *et al.* 2014. Cancer in British vegetarians: updated analyses of 4998 incident cancers in a cohort of 32,491 meat eaters, 8612 fish eaters, 18,298 vegetarians, and 2246 vegans. *American Journal of Clinical Nutrition*. 100 (1 Suppl) 378S-385S.
- Kobayashi M *et al.* 2018. Pathological roles of iron in cardiovascular disease. *Current Drug Targets*. 19 (9) 1068-1076.
- Korakas E *et al.* 2018. Dietary composition and cardiovascular risk: a mediator or a bystander? *Nutrients*. 10 (12) 1912.
- Larsen MH *et al.* 2014. Persistence of foodborne pathogens and their control in primary and secondary food production chains. *Food Control*. 44: 92-109.
- Le LT and Sabaté J. 2014. Beyond meatless, the health effects of vegan diets: findings from the Adventist cohorts. *Nutrients*. 6 (6) 2131-2147.
- Lee KW *et al.* 2020. Effects of vegetarian diets on blood pressure lowering: a systematic review with meta-analysis and trial sequential analysis. *Nutrients*. 12 (6) 1604.
- Li SS *et al.* 2017. Effect of plant protein on blood lipids: a systematic review and meta-analysis of randomized controlled trials. *Journal of the American Heart Association*. 6 (12) e006659.
- Li R *et al.* 2018. Dietary factors and risk of gout and hyperuricemia: a meta-analysis and systematic review. *Asia Pacific Journal of Clinical Nutrition*. 27(6):1344-1356.
- Lichtenstein AH *et al.* – American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; and Stroke Council. 2021. 2021 Dietary Guidance to Improve Cardiovascular Health: A Scientific Statement From the American Heart Association. *Circulation*. CIR0000000000001031.
- Lund BM. 2015. Microbiological food safety for vulnerable people. *International Journal of Environmental Research and Public Health*. 12 (8) 10117-10132.
- Maloberti A *et al.* 2021. The role of uric acid in acute and chronic coronary syndromes. *Journal of Clinical Medicine*. 10 (20) 4750.

- Mangano KM *et al.* 2014. Dietary acid load is associated with lower bone mineral density in men with low intake of dietary calcium. *Journal of Bone Mineral Research*. 29 (2) 500-506.
- Manyi-Loh C *et al.* 2018. Antibiotic use in agriculture and its consequential resistance in environmental sources: potential public health implications. *Molecules*. 23 (4) 795.
- Mathew AG *et al.* 2007. Antibiotic resistance in bacteria associated with food animals: a United States perspective of livestock production. *Foodborne Pathogens and Disease*. 4 (2) 115-133.
- Matsumoto S *et al.* 2019. Association between vegetarian diets and cardiovascular risk factors in non-Hispanic white participants of the Adventist Health Study-2. *Journal of Nutrition Science*. 8, e6.
- McMacken M and Shah S. 2017. A plant-based diet for the prevention and treatment of type 2 diabetes. *Journal of Geriatric Cardiology*. 14 (5) 342-354.
- Micha R *et al.* 2010. Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: a systematic review and meta-analysis. *Circulation*. 121 (21) 2271-2283.
- Micha R *et al.* 2012. Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes—an updated review of the evidence. *Current Atherosclerosis Reports*. 14 (6) 515-524.
- Morino K *et al.* 2006. Molecular mechanisms of insulin resistance in humans and their potential links with mitochondrial dysfunction. *Diabetes*. 55 (Suppl. 2) S9-S15
- Najjar RS and Feresin RG. 2019. Plant-based diets in the reduction of body fat: physiological effects and biochemical insights. *Nutrients*. 11 (11) 2712.
- Niki E. 2011. Do free radicals play causal role in atherosclerosis? Low density lipoprotein oxidation and vitamin E revisited. *Journal of Clinical Biochemical Nutrition*. 48 (1) 3-7.
- O'Neill J. 2016. Tackling drug-resistant infections globally: final report and recommendations. London, UK: review on antimicrobial resistance. 1-84.
- Pan A *et al.* 2012. Red meat consumption and mortality: results from 2 prospective cohort studies. *Archives of Internal Medicine*. 172 (7) 555-563.
- Pettersen BJ *et al.* 2012. Vegetarian diets and blood pressure among white subjects: results from the Adventist Health Study-2 (AHS-2). *Public Health Nutrition*. 15 (10) 1909-1916.
- Phillips DH. 1999. Polycyclic aromatic hydrocarbons in the diet. *Mutation Research*. 443 (1-2) 139-147.
- Qi L *et al.* 2007. Heme iron from diet as a risk factor for coronary heart disease in women with type 2 diabetes. *Diabetes Care*. 30 (1) 101-106.
- Rohrmann S *et al.* 2013. Meat consumption and mortality – results from the European Prospective Investigation into Cancer and Nutrition. *BMC Medicine*. 11, 63.
- Rouhani MH *et al.* 2014. Is there a relationship between red or processed meat intake and obesity? A systematic review and meta-analysis of observational studies. *Obesity Reviews*. 15 (9) 740-748.
- Salas-Salvadó J *et al.* 2019. Dietary patterns emphasizing the consumption of plant foods in the management of type 2 diabetes: a narrative review. *Advances in Nutrition*. 10 (Suppl_4) S320S331.
- Schlesinger S *et al.* 2019. Food groups and risk of overweight, obesity, and weight gain: a systematic review and dose-response meta-analysis of prospective studies. *Advances in Nutrition*. 10 (2) 205-218.
- Scialla JJ and Anderson CA. 2013. Dietary acid load: a novel nutritional target in chronic kidney disease? *Advances in Chronic Kidney Disease*. 20 (2) 141-149.
- Sparks LM *et al.* 2005. A high-fat diet coordinately downregulates genes required for mitochondrial oxidative phosphorylation in skeletal muscle. *Diabetes*. 54 (7) 1926-33.
- Stein RA and Katz DE. 2017. *Escherichia coli*, cattle and the propagation of disease. *FEMS Microbiology Letters*. 364 (6).
- Steinbrecher A *et al.* 2011. Meat consumption and risk of type 2 diabetes: the Multiethnic Cohort. *Public Health Nutrition*. 14(4):568-74.
- Sun Y *et al.* 2016. A healthy dietary pattern reduces lung cancer risk: a systematic review and meta-analysis. *Nutrients*. 8 (3).
- Tantamango-Bartley Y *et al.* 2013. Vegetarian diets and the incidence of cancer in a low-risk population. *Cancer Epidemiology and Biomarkers Prevention*. 22 (2) 286-294.
- Tuan Zainazor C *et al.* 2010. The scenario of norovirus contamination in food and food handlers. *Journal of Microbiology and Biotechnology*. 20 (2) 229-237.
- Turner-McGrievy GM *et al.* 2015. Comparative effectiveness of plant-based diets for weight loss: a randomized controlled trial of five different diets. *Nutrition*. 31 (2) 350-358.
- Turner-McGrievy G *et al.* 2017. A plant-based diet for overweight and obesity prevention and treatment. *Journal of Geriatric Cardiology*. 14 (5) 369-374.
- van der A D *et al.* 2004. Dietary haem iron and coronary heart disease in women. *European Heart Journal*. 26 (3) 257-262.
- Vang A *et al.* 2008. Meats, processed meats, obesity, weight gain and occurrence of diabetes among adults: findings from adventist health studies. *Annals of Nutrition and Metabolism*. 52 (2) 96-104.
- Veetil SK *et al.* 2021. Role of diet in colorectal cancer incidence: umbrella review of meta-analyses of prospective observational studies. *JAMA Network Open*. 4 (2) e2037341.
- Vergnaud AC *et al.* 2010. Meat consumption and prospective weight change in participants of the EPIC-PANACEA study. *American Journal of Clinical Nutrition*. 92 (2) 398-407.
- Wang Y and Beydoun MA. 2009. Meat consumption is associated with obesity and central obesity among US adults. *International Journal of Obesity*. 33 (6) 621-628.
- Weaver CM *et al.* 2016. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporosis International*. 27 (4): 1281-1386.
- Wei X *et al.* 2021. Diet and risk of incident lung cancer: a large prospective cohort study in UK Biobank. *American Journal of Clinical Nutrition*. nqab298.
- Weikert C *et al.* 2005. The relation between dietary protein, calcium and bone health in women: results from the EPIC-Potsdam cohort. *Annals of Nutrition and Metabolism*. 49 (5) 312-318.
- Wolk A. 2017. Potential health hazards of eating red meat (Review). *Journal of Internal Medicine*. 281, 106-122.
- Xue XJ *et al.* 2014. Red and processed meat consumption and the risk of lung cancer: a dose-response meta-analysis of 33 published studies. *International Journal of Clinical Experimental Medicine*. 7 (6) 1542-1553.
- Yang WS *et al.* 2012. Meat consumption and risk of lung cancer: evidence from observational studies. *Annals of Oncology*. 23 (12) 3163-3170.
- You W and Henneberg M. 2016. Meat consumption providing a surplus energy in modern diet contributes to obesity prevalence: an ecological analysis. *BMC Nutrition*. 2 (1).
- You W and Henneberg Y. 2016a. Meat in modern diet, just as bad as sugar, correlates with worldwide obesity: An ecological analysis. *Journal of Nutrition and Food Sciences*. 6 (4) 517.
- Zhang Q *et al.* 2010. The association between dietary protein intake and bone mass accretion in pubertal girls with low calcium intakes. *British Journal of Nutrition*. 103 (5) 714-723.
- Zhang R *et al.* 2021. Processed and unprocessed red meat consumption and risk for type 2 diabetes mellitus: an updated meta-analysis of cohort studies. *International Journal of Environmental Research and Public Health*. 18 (20) 10788.