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EFFECTS OF MEAT CONSUMPTION ON CONSUMERS' HEALTH

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Abstract

Meat is a major part of human diets for centuries, a source of protein and essential nutrients, but concerns have been raised about the potential negative health impacts associated with high meat consumption. This review paper aims to provide an overview of the current scientific evidence on the effects of meat consumption on consumer health. The review covers the evidence on the relationship between meat consumption and various health outcomes, including cardiovascular disease, cancer, type 2 diabetes, and obesity. The review discusses the potential for promoting healthy meat consumption patterns and recommendations for consumers and policy-makers to reduce meat consumption and promote healthier dietary choices. Overall, the review highlights the complex relationship between meat consumption and consumer health, and the need for further research to better understand this relationship and inform public health policy and dietary guidelines.

Key words*: healthy food, meat processing, nutritional quality.*

INTRODUCTION

Meat represents an important source of high-quality dietary protein for a large proportion of the global population. Meat consumption is a highly debated topic worldwide, with concerns about its impact on human health, the environment, and animal welfare. Meat is a major source of protein and micronutrients, including iron, zinc, selenium, vitamin D and vitamin B12, in many diets, but overconsumption has been linked to various health issues, including heart disease, stroke, cancer, and diabetes (Salter, 2018).

Meat consumption trends vary greatly across the globe. Furthermore, some individuals choose to either avoid meat altogether or certain types of meat for a variety of reasons, such as ethical or religious reasons, or because of socio-economic factors

For many in the developed world, meat is readily available and affordable, and represents a routine component of their diet. Consumption of even relatively small amounts of meat and other animal products can have a major impact on preventing protein-energy malnutrition, iron deficiency, anaemia and vitamin (Smith et al., 2013). At a global level, according to the Food and Agriculture Organization (FAO), global meat production has tripled over the past four decades, and it is projected to continue increasing in the coming years. This trend raises concerns about the environmental impact of meat production, including greenhouse gas emissions and water consumption, as well as the potential health consequences of increased meat consumption. Of the emission of greenhouse gas pollutants produced in the livestock sector, 80% comes from the growth of ruminants (Marin et al., 2020).

Meat consumption has been steadily increasing over the past few decades, with a significant increase reported in developing countries and is expected to double by 2050.

This trend is concerning given the potential health impact of consuming excessive amounts of meat, particularly fatty meat. As such, there is a growing need for research to examine the relationship between fatty meat consumption and health outcomes in order to inform public health policies and dietary guidelines

In Europe, meat consumption varies widely between countries and regions, with some countries consuming more than others.

According to Eurostat, the EU statistical office, in 2023, the average per capita meat consumption in the European Union was 66.13 kg, with the highest consumption reported in Luxembourg (107.9 kg) and the lowest in Albania (41 kg). In Romania, in 2021, cattle provided 4.69 kg of meat per capita, pigs provided 13.72 kg of meat per capita, while sheep and goat species contributed 5.84 kg of meat per capita, goats providing less than 2 kg of meat per capita (Maloş & Maloş, 2022).

Also, world carcass meat production that includes both commercial and farm slaughter has increased steadily from 1990 to the present (Figure 1).

Studying the effects of fatty meat consumption on consumer health is important because meat is a significant source of dietary fat, and excessive consumption of fatty meat has been linked to various health issues. The high fat content in meat, particularly saturated and trans fats, has been associated with increased risk of cardiovascular disease, obesity, type 2 diabetes, and certain types of cancer (Battaglia et al., 2015). A hypocaloric alternative to meat products can be obtained by including vegetable derivatives (soy, starch, chickpea, etc.) in the meat compositions, with the obtaining of nutritionally enriched products and sensorially close to the classic ones, at the same time capitalizing on secondary products of the food industry (Ianiţchi et al., 2023).

Meat can also be a source of contamination with microorganisms, the most important being raw meat, thermally processed meats having a much reduced microbial contamination (Şuler et al., 2021).

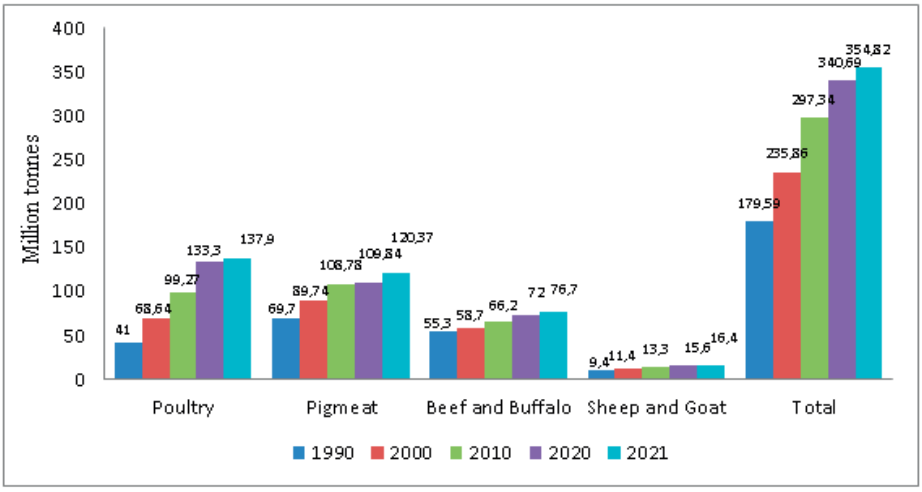

Figure 1. Meat production (carcass weight) in the period 1990-2021 (Ritchie et al., 2017)

MATERIALS AND METHODS

The paper aims to contribute to the review of various studies on the impact of meat and especially red and fatty meat consumption on humans' health. The study considered the follow-up of research published in the last years. Works published in open access scientific journals from databases such as Web of Science, ResearchGate and Google Scholar were studied.

The effects of the consumption of fatty meat on the health of consumers have been studied in order to find explanations for the various disorders that appear depending on the diet. Knowing these effects, many of them negative, it is necessary to look for alternatives in order to combat the associated diseases. In addition to some diets based on the predominant consumption of vegetables and fruits, an alternative can be obtaining an innovative preparation, made of minced beef, with added fiber. This low-calorie product, therefore with less fat, can contribute to reducing the occurrence of coronary diseases, obesity and diabetes.

The paper can be a basis for studies aimed at replacing conventional meat and meat products with alternative improved meat products.

RESULTS AND DISCUSSIONS

Following the bibliographic study carried out in the paper, it was established that the consumption of certain categories of meat and meat products is widespread throughout the world, both in developed and less developed countries, at any level and social status. Also, the consumption of these meat products can lead to the appearance of diseases under certain conditions and under the influence of certain factors.

Definition and types of meat

Fatty meat refers to types of meat that have a high fat content. These types of meat are often associated with a richer flavor and juicier texture, but can also have negative health effects if consumed in excess.

There are several types of fatty meat, including:

- Beef: Certain cuts of beef, such as ribeye, short ribs, and brisket, are high in fat content.
- Pork: Pork can be particularly fatty, especially cuts like bacon, pork belly, and sausage.
- Lamb: Lamb can also be high in fat, particularly the shoulder and leg.
- Poultry: While poultry is typically considered a leaner source of protein, some cuts like chicken wings and thighs can be high in fat content.
- Processed meats: Processed meats such as hot dogs, sausages, and deli meats are often high in fat content and may also contain added preservatives and chemicals.

It's important to note that not all fat in meat is unhealthy - some types of fat, like monounsaturated and polyunsaturated fats, can have positive health effects in moderation.

"Red meat" refers to beef, pork, lamb, goat meat that comes from domestic animals, including that contained in processed foods and most beef burgers. This category does not include poultry, wild game, or offal (however, the impact of organ consumption and wild game consumption on cancer risk is unknown). Although eating red meat in large amounts increases the risk of developing bowel cancer, red meat is also a good source of nutrients. In principle, it is recommended to avoid eating more than about 500 grams of red meat per week (500 grams of cooked meat, which is equivalent to about 700-750 grams of raw meat, depending on how is cut and cooked).

"Processed meat" refers to meat preserved by smoking, aging/maturing, salting or the addition of chemical preservatives. This category includes, for example, ham, bacon, salami and some sausages, such as frankfurters. As the consumption of processed meat is also positively associated with the risk of bowel cancer, even in smaller amounts, and does not provide any additional nutritional benefit over red meat, it is recommended to avoid processed meat as much as possible, for reducing the risk of cancer. (Linseisen et al., 2002; IARC, 2016).

The nutrient content and nutritional value of meat

The nutritional value of meat varies considerably, depending on the species, breed and even geographic region or country.

The chemical composition of meat is different within the same species, varying from one individual to another, depending on the ratio between different tissues (muscle tissue/adipose tissue), the age of the animal, the season of the year, the animal diet and state of fattening.

Also, differences appear depending on the particular cut of meat, the method of preservation and the method of cooking.

Some of the key nutrients found in meat include:

- protein: meat is a high-quality source of protein, which is important for building and repairing tissues in the body;
- iron: meat is a particularly rich source of heme iron, which is more easily absorbed by the body than non-heme iron found in plant-based foods. Iron is important for the production of hemoglobin, which carries oxygen in the blood;
- zinc: meat is also a good source of zinc, which is important for immune function and wound healing;
- B vitamins: Meat is one of the few dietary sources of vitamin B12, which is only found in animal-based foods and is essential for the proper functioning of the nervous system and the formation of red blood cells. Meat is a rich source of several B vitamins, such as thiamin, riboflavin, and niacin, which are important for energy metabolism.

Red meat contains high biological value protein and important micronutrients, all of which are essential for good health throughout life. Meat is a source of fat and contributes to intake of saturated fatty acids (SFAs). However, meat contains a range of fatty acids, including the essential omega-6 (n-6) and omega-3 (n-3) poly-unsaturated fatty acids (PUFAs) [linoleic and a-linolenic acids (ALNAs)] (Wyness et al., 2011).

The water content of meat varies inversely proportional to that of fat. In cattle it is 60-76%, in pigs 51-73%, in sheep 53-74%, in chickens 65.5-71%, in turkeys 60.0-69%, and in game between 69 and 74%.

The content of protein substances varies depending on the species and the state of fattening, being higher in poultry meat (12-24%) and moderate in the meat of slaughter animals (15-21%).

It was believed about meat that it would be the most protein food, but scientific data come to disprove these outmoded statements, as follows: meat contains 17-25% protein, while soy extract - 94%, tofu sheets - 54%, dried soy beans - 35%, seaweed - 35%, pumpkin seeds - 29%, chickpeas 28%, peanuts 26%, lentils 24%, sunflower seeds 24%, almonds 20%, barley 13%;

The lipid content varies depending on the state of fattening: cattle 3.0-20.0%; pigs 3.0-34%; sheep 3.7-26.0%; chickens 6.9-13.7%, ducks 23-37.0%, domestic rabbit about 10%. They are mostly composed of neutral glycerides and small amounts of phospholipids 0.5-0.9% (lecithins, cephalins, etc.) and steroids (cholesterol) about 0.8%.

The content of nitrogenous substances is 1-1.7% and consists of: amino acids, dipeptides (carnosine, anserine), tripeptides (glutathione), carnitine, nucleotides, purine bases (xanthine, hypoxanthine, and uric acid), creatine, and phosphocreatine.

The content of non-nitrogenous extractive substances is 2-3% and is mainly represented by glycogen, as a reserve of carbohydrates in the liver and in small quantities as a source of "immediate" energy in the muscles, followed by inositol, glucose, lactic acid, formic acid, malic acid.

The content of mineral substances in meat varies between 0.7-1.5%. The composition of mineral salts in meat includes: potassium (0.3-0.35%), iron (0.1-0.22%), phosphorus, sulfur, sodium (0.4-0.7%), magnesium and smaller amounts of calcium, etc.; the presence of easily assimilable iron from meat favors the formation of red blood cells.

The content of vitamins in meat is variable, being influenced by the same factors mentioned in the chemical composition.

Thus, vitamin A is found in the liver; vitamin B1 especially in the liver, heart, kidneys and muscles, vitamin B2 in the liver, kidneys, heart; vitamin B6 in cattle liver, pork and cow muscle, heart; vitamin PP in the liver, kidneys and muscles; pantothenic acid in the liver, kidneys and muscles, brain and heart; folic acid and vitamin B12 predominate in the liver. Vitamins C, D and E are found in meat in small quantities.

Table 1 provides some examples of the major macronutrient content of some common, relatively lean cuts of grilled meat, compared to a variety of non-meat, plant-based staples.

It is clear that, compared to carbohydrate-rich plant foods, all these meats are protein-rich. The red meats are also richer in total and saturated fats. By contrast, chicken is relatively low in fat. However, meat is not only rich in protein, but the protein is generally of higher quality (i.e. contains more essential amino acids) than plant equivalents. Perhaps unsurprisingly, as it comes from the muscle of other animals, it contains all the essential amino acids, in the appropriate proportions, to fulfil the nutritional requirements of humans.

Fatty meat is a type of meat that has a higher fat content compared to lean meat. Generally, it contains higher amounts of saturated fat and cholesterol compared to lean meat.

Saturated fat is a type of fat that is typically solid at room temperature and is commonly found in animal products. Consuming high amounts of saturated fat has been associated with an increased risk of heart disease and stroke. Fatty meat, particularly red meat, is a major source of saturated fat in the diet.

Cholesterol is a type of lipid or fat that is present in animal foods, including meat. It plays an important role in the body, but high levels of cholesterol in the blood have been linked to an increased risk of heart disease.

Fatty meat, particularly organ meats like liver and kidney, are particularly high in cholesterol.
The nutrient content of different types of fatty meat can vary. For example, a 100-gram serving of cooked beef brisket contains about 14 grams of fat, while the same serving size of cooked pork belly contains about 30 grams of fat. Similarly, a 100-gram serving of cooked chicken thigh with skin contains about 10 grams of fat, while the same serving size of cooked duck with skin contains about 25 grams of fat.

In their paper Wyness et al., 2011 notes that while red meat is a good source of important nutrients such as protein, iron, and zinc, consuming high amounts of red meat, particularly processed meats, has been associated with an increased risk of several chronic diseases. For example, studies have found that consuming more than 100 grams of red meat per day is associated with an increased risk of colorectal cancer, as well as cardiovascular disease.

Table 1. Macronutrient content of various meats compared to some plant derived foods (Roe, 2015)

Meet	Energy, KJ/100 g	Protein	Fat	SFA	Carbohydrate	Reviewed
			g/100 g			
Beef	745	31.0	5.9	2.5	0	Reviewed 2013. LGC, Nutrient analysis of carcase beef, 1992-1993; ISO/IEC 17043:2010
Lamb	1,268	26.5	22.1	10.5	0	Reviewed 2013. LGC, Nutrient analysis of retail cuts of lamb, 1993-1994;
Pork	1,078	27.5	16.5	5.7	0	LGC, Nutrient analysis of retail cuts of pork, 1992-1993
Chicken	626	32.0	2.2	0.6	0	Reviewed 2013. LGC, Nutrient analysis of chicken and turkey, 1994-1995
Bread	931	7.9	1.6	0.3	42.7	LGC, Nutrient analysis of bread and morning goods, 1999; and industry data, 2013
Potatoes	413	2.5	0.2	0.1	21.2	DH, Nutrient analysis of fruit and vegetables, 2013
Rice	560	2.8	0.4	0.1	31.1	LGC, Nutrient survey of flours and grains, 2005

KJ: kilojoules
SFA: Saturated fatty acids
Values are per 100 g serving of grilled meat (beef rump steak, lamb loin chop, pork loin chop or chicken breast), white bread, baked potato or boiled rice.

Overall, the paper concludes that while red meat can be part of a healthy diet, it's important to consume it in moderation, and to choose lean cuts and healthy cooking methods. The paper also recommends increasing the consumption of plant-based foods, such as fruits, vegetables, and whole grains, which are associated with a range of health benefits.
It is also important to note that not all meats are equally nutritious. For example, processed meats, such as bacon, sausage, and deli meats, are often high in sodium, preservers, stabilizers and other food additives, which can contribute to negative health effects. Red meat, such as beef, pork, and lamb, has been associated with an increased risk of several chronic diseases, such as heart disease and certain types of cancer, when consumed in high amounts, but this also depends to a large extent on the way the meat is prepared (Pereira et al., 2013).
The consumption of red and fatty meat has been linked to several potential health hazards (Wok, 2016). Here are some of the most notable:
1. Cardiovascular disease: High intake of red meat, particularly processed meat, has been associated with an increased risk of cardiovascular disease, such as heart disease and stroke. The high levels of saturated fat and cholesterol in red meat can contribute to the build-up of plaque in the arteries, leading to reduced blood flow and increased risk of heart attack and stroke.
2. Colorectal cancer: Regular consumption of red meat has been linked to an increased risk of colorectal cancer. The potential mechanism for

this relationship may be related to the presence of harmful compounds formed during cooking or processing of meat, as well as the heme iron and saturated fat content of red meat.
3. Type 2 diabetes: Eating large amounts of red meat has been associated with an increased risk of type 2 diabetes, likely due to the high levels of saturated fat and heme iron in red meat, as well as its impact on insulin resistance and inflammation (Salter, 2013).
4. Obesity: A high intake of red meat, particularly processed meat, has been linked to an increased risk of obesity. Red meat is often high in calories and saturated fat, which can contribute to weight gain.
5. Inflammatory bowel disease: Some studies have suggested that high consumption of red meat may increase the risk of inflammatory bowel disease, including Crohn's disease and ulcerative colitis.
Some studies have found a positive association between meat consumption and these diseases, the evidence is not consistent and other factors, such as overall dietary patterns and lifestyle behaviors, may play a role (Williamson et al., 2005)
The articles also reviews the potential health benefits of consuming meat, such as improved cognitive function, and the importance of choosing lean cuts of meat and cooking methods that minimize the formation of harmful compounds.

Meat consumption and obesity and risk of nonalcoholic fatty liver disease
Meat consumption, including both unprocessed and processed red meat, was associated with significantly increased risk of developing NAFLD. NAFLD is a common condition in which excess fat accumulates in the liver, and it has been associated with an increased risk of liver damage and other health problems. This association was mediated largely by obesity
There are several mechanisms through which fatty meat consumption may contribute to weight gain and obesity:
1. High calorie density: Fatty meat is energy-dense and high in calories, meaning it provides a lot of calories in a small amount of food. This can lead to overconsumption of calories, which can contribute to weight gain.
2. Low satiety: Fatty meat may not be as satiating as other types of protein sources, such as lean meat or plant-based proteins. This can lead to overconsumption and increased calorie intake.
3. Impact on gut microbiota: Some research suggests that high intake of animal-based products, including fatty meat, can negatively affect the composition of the gut microbiota. This can lead to increased inflammation and insulin resistance, which can contribute to weight gain and obesity.
4. Hormonal changes: Fatty meat consumption may also impact hormone levels, including insulin and leptin. Insulin resistance can contribute to weight gain, while low levels of leptin, which regulates appetite, can lead to overconsumption of food.
5. Processed meat: Some types of fatty meat, particularly processed meats such as bacon, sausages, and hot dogs, may contain additives and preservatives that can contribute to weight gain and other negative health outcomes.
Overweight and obesity is an increasing public health problem worldwide, affecting people of all ages (both adults and children) and socio-economic groups. Globally, 57.8% of adults are estimated to have obesity by 2030 (Kelly et al., 2008).
Obesity is a condition in which an individual has an excess amount of body fat. It is typically defined as having a body mass index (BMI) of 30 or higher. BMI is a measure of body weight relative to height, calculated by dividing a person's weight in kilograms by their height in meters squared.
Obesity is a major public health concern, as it increases the risk of many serious health problems. These can include type 2 diabetes, high blood pressure, heart disease, stroke, certain types of cancer, and osteoarthritis. Obesity can also lead to psychological and social problems, such as low self-esteem and discrimination
Obesity is a complex disorder with a diverse range of causal factors, including genetics, lifestyle habits, and environmental factors (Katz, 2016). Diet, as an environmental factor, is one of the most important contributors to the obesity pandemic (Hill et al, 2000). Meats are a part of the human diet, which not only provide protein and high-quality nutrients, but also are

a main source of saturated fatty acids and cholesterol (Dabbagh-Moghadam et al., 2017). Some of the most significant lifestyle factors that can contribute to obesity include consuming a high-calorie diet, engaging in physical inactivity, and getting insufficient sleep.

For an individual to become obese, energy intake must be higher than energy expenditure for an extended period of time. This means that either more energy than needed is consumed and/or that too little energy is used by the body because of a lack of physical activity. In general, weight gain seems to be a result of a combination of both increased energy intake and decreased energy expenditure. The wide range of etiological factors makes obesity both a complex and challenging disorder (Jebb et al., 2007).

The report of Jebb et al. (2007) found that obesity was a major public health issue in the UK, with around one-third of the adult population classified as obese. The authors highlighted the significant health and economic costs associated with obesity, including increased risks of cardiovascular disease, type 2 diabetes, and certain types of cancer, as well as increased healthcare costs and lost productivity and recommended a range of interventions, including promoting healthier diets and physical activity, improving the food environment, and increasing access to weight management services.

Treatment for obesity typically involves a combination of dietary changes, increased physical activity, and behavioral therapy. In some cases, medications or weight loss surgery may also be recommended. Preventing obesity is an important public health goal, and can be achieved through promoting healthy eating habits, encouraging physical activity, and addressing environmental factors that contribute to the development of obesity.

After controlling for potential covariates including energy intake, age, marital status, gender, physical activity, supplement use, house possession, education, family size, current smoking, night shift working, history of thyroid disease and depression, and intakes of vegetables, legumes, nuts, fruits, whole grains, and dairy, some studies suggests that a diet high in poultry and white meat is positively associated with the odds of general obesity, while a diet high in processed meat is related to elevated odds of central obesity (Khodayari et al., 2022, Dabbagh-Moghadam et al., 2017).

In one study, Kim et al. (2022) analyzed data from more than 43,000 women who participated in the Nurses' Health Study II, a large, long-term study of women's health.

The participants completed food frequency questionnaires to assess their dietary intake, including their consumption of red meat, and were followed up for a period of more than 20 years to track the incidence of NAFLD. The study found that higher red meat consumption was associated with an increased risk of NAFLD, and this association was stronger among women who were overweight or obese. Specifically, women who consumed more than one serving of red meat per day had a 20% higher risk of developing NAFLD compared to women who consumed less than one serving per week. The association between red meat consumption and NAFLD was independent of other dietary and lifestyle factors, such as alcohol consumption and physical activity.

In the study of Recaredo et al. (2019), the authors investigated the association between different animal protein sources and liver status in obese subjects with non-alcoholic fatty liver disease (NAFLD). The study included 59 subjects with NAFLD who were divided into two groups based on their intake of animal protein from red meat, poultry, or fish. The researchers measured liver enzymes, insulin resistance, and other markers of liver health in the study participants.

The study found that the intake of red meat was associated with higher levels of liver enzymes, insulin resistance, and worse liver health, while the intake of poultry and fish did not show significant associations with liver status. The authors suggest that reducing red meat intake and increasing the consumption of poultry and fish may be beneficial for individuals with NAFLD.

The study by Noureddin et al. (2020) aimed to investigate the associations between dietary factors and nonalcoholic fatty liver disease (NAFLD) in an ethnically diverse population. The researchers analyzed data from the Multiethnic Cohort, a large population-based study of adults in Hawaii and Los Angeles. The

study included 4,227 participants who completed a food frequency questionnaire and underwent abdominal computed tomography to assess liver fat content.

The results showed that participants who consumed the most fatty/red and processed meat had a 45% higher odds of NAFLD compared to those who consumed the least amount. On the other hand, participants who consumed the most fruits and vegetables had a 30% lower odds of NAFLD compared to those who consumed the least amount. The study also found that the association between meat and processed meat consumption and NAFLD was stronger in women than in men, and in those with a higher body mass index (BMI). The association between fruits and vegetables and NAFLD was stronger in men than in women, and in those with a lower BMI.

Another study aimed to investigate the association between red and processed meat consumption and non-alcoholic fatty liver disease (NAFLD) and insulin resistance. The study was conducted in Israel and included 789 adults who underwent abdominal ultrasound and blood tests. The results showed that high consumption of red and processed meat was significantly associated with NAFLD and insulin resistance, even after adjusting for potential confounders such as age, sex, smoking, physical activity, and calorie intake. The study concluded that reducing red and processed meat consumption may be an important strategy for preventing NAFLD and related metabolic disor-ders (Zelber-Sagi et al., 2018).

A 2014 systematic review and meta-analysis of 29 observational studies found that high consumption of processed meat was associated with a higher risk of obesity than high consumption of unprocessed red meat (Schwingshackl & Hoffmann, 2014).

Another study conducted by Lutsey et al. (2008) examined the relationship between meat consumption and body mass index (BMI) in a sample of over 9,000 middle-aged adults. The study found that individuals who consumed the highest levels of red meat had higher BMIs than those who consumed the least amount of red meat. Similarly, other studies found that high intake of meat and processed meat is associated with a higher risk of weight gain and obesity (Vergnaud et al., 2010; Rouhani et al., 2014).

In addition to observational studies, several randomized controlled trials have investigated the effect of reducing meat intake on weight and body composition. One such trial by Barnard et al. (2009) found that a plant-based diet led to significantly greater weight loss and reduction in BMI compared to a control group consuming a standard American diet that included meat.

The mechanisms underlying the association between fatty meat consumption and obesity are likely multifactorial. As mentioned earlier, the high calorie and saturated fat content of fatty meat may contribute to weight gain and obesity when consumed in excess. Additionally, some studies have suggested that heme iron, a type of iron found in red meat, may also play a role in the development of obesity through its impact on gut bacteria and inflammation (Tang et al., 2013).

A study by Babio et al. (2014) in Spain found that a high consumption of red and processed meat was associated with a higher risk of obesity, as well as other cardiometabolic risk factors. Similarly, a study by Zhu et al. (2019) in China found that higher intake of red and processed meat was associated with a higher risk of abdominal obesity in both men and women.

Fatty meat consumption and cardiovascular health

A number of studies (mostly in Europe and the United States of America) have suggested a link between red and/or processed meat consumption and the risk of CVD and that the greatest consumers of meat had a 40% increased risk of dying from CVD (Rohrmann et al., 2013; Koeth et al., 2013).

CVD is a group of disorders that affect the heart and blood vessels and includes conditions such as coronary heart disease, stroke, and peripheral arterial disease. Studies have shown that consuming high amounts of saturated fat, which is found in fatty meat, can raise blood cholesterol levels and increase the risk of CVD.

A mechanisms through which the consumption of fatty meat may contribute to the development of cardiovascular disease (CVD) include the high levels of saturated and trans-

fats. Fatty meat is often high in saturated and trans-fats, which are known to increase levels of LDL cholesterol (the "bad" cholesterol) in the blood. This can lead to the formation of plaques in the arteries, which can increase the risk of heart disease and stroke. Fatty meat consumption may also contribute to an inflammatory response in the body, which has been linked to the development of CVD. The excess fat and cholesterol in the diet can activate immune cells, leading to the release of inflammatory molecules that can damage the lining of blood vessels.

Numerous studies have investigated the relationship between fatty meat consumption and cardiovascular disease (CVD). A meta-analysis of 20 prospective cohort studies found that high consumption of meat was associated with a significantly increased risk of CVD, including coronary heart disease and stroke (Wang et al., 2016). The study also showed that replacing meat with plant-based protein sources was associated with a lower risk of CVD.

Another study that analyzed data from over 400,000 participants found that high intake of meat was associated with an increased risk of CVD mortality, particularly among men (Zhong et al., 2020).

It is important to note that not all studies have found a clear link between fatty meat consumption and CVD. Some studies have suggested that the quality of the meat consumed, as well as the cooking method, may play a role in its potential health effects. However, overall, evidence suggests that consuming high amounts of fatty meat can increase the risk of CVD, and reducing its consumption may be beneficial for cardiovascular health.

The research article by Astrup et al. (2011) reviewed the available evidence on the relationship between saturated fat intake and the risk of cardiovascular disease (CVD) and concluded that reducing intake of saturated fat can lower the risk of CVD. The authors discussed the findings of several studies, which provided evidence for the role of saturated fat in the development of CVD. The authors also discussed the potential mechanisms by which saturated fat intake may increase the risk of CVD, such as raising LDL cholesterol levels and promoting inflammation. The article emphasized the importance of replacing saturated fat with healthy unsaturated fats, such as those found in nuts, seeds, vegetable oils, and fatty fish.

The study conducted by Appel et al. in 1997 was a randomized clinical trial that investigated the effects of dif-ferent dietary patterns on blood pressure. The participants were 459 adults with prehypertension or stage 1 hypertension, who were randomly assigned to one of three dietary groups: a control group that followed a typical American diet, a fruits and vegetables group that consumed a diet rich in fruits and vegetables but low in fat and dairy products, and a combination group that followed the fruits and vegetables diet as well as the DASH (Dietary Approaches to Stop Hypertension) diet, which is rich in fruits, vegetables, and low-fat dairy products and low in saturated and total fat. The study found that the combination group had the greatest reductions in blood pressure, followed by the fruits and vegetables group, compared to the control group. The study suggests that dietary patterns that emphasize fruits, vegetables, and low-fat dairy products can have beneficial effects on blood pressure, which is a risk factor for cardiovascular disease.

While many studies have found a link between fatty meat consumption and increased risk of cardiovascular disease (CVD), some studies have not found a clear association. A systematic review and meta-analysis of prospective cohort studies found that high consumption of red and processed meat was associated with increased risk of coronary heart disease (CHD) but not stroke (Micha et al., 2010). Study by Guasch-Ferré et al. (2019) found no significant association between meat intake and incident cardiovascular disease, coronary heart disease, or stroke in women.

Fatty meat consumption and diabetes

A number of studies have reported a link between red and processed meat consumption and the risk of devel-oping T2D. Type 2 diabetes is strongly associated with obesity and, as a high consumption of meat is frequently asso-ciated with energy-dense diets, often in combination with low physical activity levels, this may explain at least part of the association. Obesity frequently leads to resistance to the

action of the hormone insulin and, in a proportion of obese people, this can develop further into T2D (Wok, 2016).

As with CVD, the high saturated fat and cholesterol content of fatty meat is thought to play a role in the devel-opment of insulin resistance and impaired glucose metabolism, which are key contributors to type 2 diabetes.

The mechanisms underlying this association are likely related to the high saturated fat and cholesterol content in fatty meat, which can lead to insulin resistance and impaired glucose metabolism. Another mechanism is the formation of advanced glycation end-products (AGEs) during the cooking of fatty meat. AGEs are formed when proteins and fats react with sugars at high temperatures, and they have been shown to increase oxidative stress and inflammation in the body, both of which are associated with insulin resistance and diabetes. In addition, fatty meat consumption has been linked to increased inflammation in the body, which is also associated with insulin resistance and diabetes. Finally, consuming high levels of saturated fat has been shown to contribute to the development of obesity, which is a major risk factor for type 2 diabetes.

Sanchis et al. (2016) study investigated the association between meat consumption and the risk of developing type 2 diabetes in a highly educated middle-class population using data from the SUN project. The authors found that a higher intake of processed meat was associated with an increased risk of developing type 2 diabetes, while no significant association was observed for total meat consumption or unprocessed red meat intake.

Another prospective cohort study by Ericson et al. (2013) found that higher consumption of processed meat was associated with an increased risk of developing type 2 diabetes, while higher consumption of poultry was associated with a lower risk. A study by Pan et al. (2011) found that higher consumption of red meat and processed meat was associated with an increased risk of developing type 2 diabetes, while higher consumption of nuts, whole grains, and dairy was associated with a lower risk.

Data from cross-sectional and prospective studies suggest that individuals who regularly consume meat products may have up to twice the risk of developing diabetes, compared with individuals who avoid meat entirely (Snowdon & Phillips, 1985; Fraser, 1999; Vang et al., 2008; Tonstad et al., 2009, 2013)

Individuals who eat meat regularly also tend to have higher plasma total and low density lipoprotein cholesterol concentrations (Barnard et al., 2009), higher blood pressure values, higher risk of hypertension (Berkow & Barnard, 2005), and higher body weight (Berkow & Barnard, 2006), all of which contribute to cardiovascular risk, the principal danger in diabetes. All of these conditions improve when meat is no longer consumed (Barnard et al., 2005; Ornish et al., 1990; 1998; Barnard et al., 2006). Meat consumption is consistently associated with diabetes risk. Dietary habits are readily modifiable, but individuals and clinicians will consider dietary changes only if they are aware of the potential benefits of doing so. The foregoing review indicates that the identification of meat consumption as a risk factor for diabetes provides helpful guidance for clinicians and at-risk individuals, and sets the stage for beneficial behavioral changes (Barnard et al., 2014).

The Women's Health Study was a prospective cohort study conducted in the United States that aimed to investigate the relationship between lifestyle, dietary factors, and the incidence of chronic diseases in middle-aged and elderly women. The study followed 37,309 female health professionals aged 45 years or older for an average of 8.2 years. The results of the study showed that women who consumed higher amounts of meat had a significantly increased risk of developing type 2 diabetes compared to those who consumed less meat. After adjusting for age, BMI, physical activity, smoking, alcohol intake, and other dietary factors, the study concluded that a high consumption of meat was associated with an increased risk of type 2 diabetes in middle-aged and elderly women. The findings supported the notion that dietary factors play a significant role in the development of type 2 diabetes and highlighted the importance of promoting healthy dietary habits to prevent this chronic disease (Song et al., 2004).

Insulin and insulin-like growth factor (IGF)-1 signaling is a proposed mechanism linking

dietary protein and major chronic diseases. However, it is unclear whether animal and plant proteins are associated with biomarkers of insulin and IGF axis. In the study of Lee at al. (2022), higher animal protein intake was associated with higher IGF-1 and lower IGFBP-1 and IGFBP-2, whereas higher plant protein intake was associated with higher IGF-1 and IGFBP-1.

Fatty meat consumption and cancer

Studies on the relationship between fatty meat consumption and cancer risk have yielded mixed results. Some studies have found a positive association between red and processed meat consumption and increased risk of certain cancers, while others have not found a significant association.

Over recent years, a number of epidemiological studies have demonstrated a link between red meat, and in par-ticular processed red meat, and the risk of cancer. In reviewing the existing evidence, the International Agency for Research on Cancer (IARC) concluded in 2015 that processed meat is carcinogenic to humans and that fresh red meat is probably carcinogenic (Bouvard et al., 2015). The mechanisms by which meat contributes to this increased cancer risk have largely been attributed to chemical carcinogens produced during curing or smoking of processed meats or through cooking meat at high temperatures (Neuman et al., 2007).

The mechanisms through which fatty meat consumption may contribute to cancer risk are not fully understood and are still being studied, but several. Some hypotheses have been proposed and there are some possible ways in which this relationship may exist. Some studies suggest that cooking meat at high temperatures, such as grilling or frying, can produce carcinogenic compounds, such as heterocyclic amines (HCAs) and polycyclic aromatic hydrocar-bons (PAHs). These compounds can damage DNA and increase the risk of cancer.

Some studies suggest that the gut microbiome may play a role in the relationship between fatty meat consumption and cancer. Consumption of high levels of saturated fat and cholesterol found in fatty meat may increase levels of certain hormone, may increase the production of bile acids and may alter the balance of gut bacteria, which can affect the immune system and inflammation levels which are associated with the development of certain types of cancer, such as breast and prostate cancer (Cross et al., 2010).

Several meta-analyses have found that high consumption of meat is associated with an increased risk of colorectal cancer. For example, a meta-analysis of 27 cohort studies found that high intake of meat was associated with a 28% increased risk of colorectal cancer (Chan et al., 2011). Similarly, a meta-analysis of 14 studies found that high consumption of processed meat was associated with a 20% increased risk of colorectal cancer (Larsson & Wolk, 2006).

A study published in 2018 reported that high intake of red and processed meat was associated with an increased risk of breast cancer (Farvid et al., 2014) and another meta-analysis published in 2014 found that high consumption of red and processed meat was associated with a modestly increased risk of breast cancer in premenopausal women.

Some studies have found a positive association between meat consumption and increased risk of pancreatic, prostate, and lung cancer, while other studies have not found a significant association. Other types of cancer have also been studied in relation to meat consumption, but the evidence is less consistent.

Overall, the evidence suggests that high consumption of red and processed meat is associated with an increased risk of colorectal cancer, but the evidence for other types of cancer is less consistent. Further research is needed to better understand the relationship between fatty meat consumption and cancer risk, and to identify the underlying mechanisms.

Alternative protein sources to fatty meat

Some article discusses the role of meat in the human diet, with a focus on the balance between the nutritional benefits of meat and its potential health risks. The authors highlight the importance of promoting a balanced diet that includes adequate amounts of meat as well as other nutrient-rich foods, such as fruits, vegetables, whole grains, and legumes, promoting a more sustainable and healthful diet (DeSmet & Vossen, 2016).

Lean meats: Chicken breast, turkey breast, lean beef, and pork tenderloin are all good sources of protein and are lower in fat than fattier cuts of meat.
Fish: Fish such as salmon, tuna, and trout are rich in protein, omega-3 fatty acids, and other important nutrients. They are also generally lower in fat than red meat.
Beans and legumes: Lentils, chickpeas, black beans, and kidney beans are all great sources of protein and fiber. They are also low in fat and can be used in a variety of dishes.
Soy products: Tofu, tempeh, and edamame are all good sources of protein and are lower in fat than fatty meats.
Nuts and seeds: Almonds, walnuts, sunflower seeds, and pumpkin seeds are all high in protein and healthy fats. They can be added to meals or eaten as a snack.
By incorporating these alternative protein sources into the diet, it can be reduced the intake of fatty meats and promote overall health and well-being. Populations following plant-based diets, particularly vegetarian and vegan diets, are at lower risk for ischemic heart disease mortality (Ferdowsian & Barnard, 2009).
There are plants with a high content of bioactive compounds, such as fruits, vegetables, herbs, spices, which can also be studied as vegetable sources with antioxidant action, to combat the action of fatty meat (Baldin, et al., 2016; Fernandes et al., 2017, Schilling, et al., 2018, Menegali, et al., 2020).
An advantage of using vegetable antioxidants would be also, in addition to reducing fats and improving the profile of fatty acids, the extending of shelf life of meat products (Selami et al., 2022).
It is possible to create a hypocaloric product made of minced beef with added fiber, but it is important to note that simply adding fiber to a product does not necessarily make it healthier or beneficial for preventing or managing coronary diseases, obesity, or diabetes. It is essential to consider the overall nutrient composition of the product, including its fat content, saturated fat content, sodium content, and added sugars, among other factors. Additionally, it is important to consider the potential environmental impact of producing such a product, as well as the ethical implications of using animal products. Therefore, any product claiming to fight these health conditions should be carefully evaluated based on its overall nutritional profile and potential impact on health and the environment.
An innovative hypocaloric product made of minced beef with added fiber could have several potential health benefits. Here are a few examples:
- Weight management: A hypocaloric product means that it contains fewer calories than regular minced beef, which could help with weight management. Additionally, the added fiber could increase satiety and help with portion control.
- Reduced risk of chronic diseases: Minced beef is a good source of protein, iron, and other essential nutrients, but it is also high in saturated fat. By reducing the fat content and adding fiber, the product could be a healthier alternative and may help reduce the risk of chronic diseases like heart disease, obesity, and diabetes.
- Improved gut health: Adding fiber to minced beef could improve gut health by promoting the growth of bene-ficial gut bacteria and increasing stool bulk, which can help with regularity and reduce the risk of constipation.
- Convenience: Minced beef is a versatile ingredient that can be used in a variety of recipes. An innovative hy-pocaloric product made of minced beef with added fiber would provide a convenient and healthy option for people who want to incorporate beef into their diet while also watching their calorie and fat intake.
However, it is important to note that the effectiveness and safety of such a product would depend on the quality of the ingredients and the processing methods used to produce it. It would also be important to ensure that the product is properly labeled and marketed to prevent any misunderstandings about its nutritional content and health benefits.

CONCLUSIONS

Some general conclusions based on existing research are:
1. High consumption of red and processed meat is associated with increased risk of several

chronic diseases, in-cluding cardiovascular disease, type 2 diabetes, and some cancers.
2. Some studies suggest that substituting red and processed meat with plant-based protein sources may have health benefits.
3. The risks associated with meat consumption may depend on factors such as the type and cut of meat, the method of cooking, and individual differences in genetics and metabolism.
4. It is important to consider the general dietary pattern and lifestyle factors, such as physical activity and smoking, in addition to meat consumption when assessing its impact on health.
Overall, the evidence suggests that reducing meat consumption, especially of red and processed meat, may have health benefits. However, more research is needed to better understand the complex relationships between meat consumption and health outcomes, and to identify specific factors that may modify the risks associated with meat consumption.

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