

Fueled by Plants: The Effects of Vegetarianism on Overall Health

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Researcher Steven Shapin of Harvard University provides a brief history of vegetarianism in his 2007 article. The ongoing debate over whether humans should eat animals or plants spans numerous centuries and is rooted in three central questions: that of religion, human health, and philosophy (Shapin, 2007). Woven through all aspects of the vegetarianism question is the issue of morality, for by consuming animals and animal products, humans, according to Shapin, deny animals rights they claim for themselves (Shapin, 2007). In the 17th and 18th century, the West grew increasingly familiar with the idea and customs of a colonized India, including that of vegetarianism. In the 18th century, a fresh movement for vegetarianism rose based on a foundation of animal rights (Shapin, 2007). Historically, the argument for vegetarianism has utilized a wide array of reasoning, including that of compassion for animals, morality, environmental protection, and the promotion of overall health. Some vegetarians include certain foods in their diets others do not, notably dairy products, seafood, and poultry, hence the development of formally recognized subcategories of vegetarians including ovo- vegetarians (inclusion of eggs), lacto-vegetarians (inclusion of dairy), lacto-ovo vegetarians, vegans (exclusion of all animal flesh and products), and others. Prior to the age of advanced technology and science, many

turned to their holy books for dietary and personal guidance and others to the renowned physicians of their time, sources certainly not immune to bias. Fortunately, current research provides scientific answers to the more concrete side of the simultaneously universal and personal question of how humans should eat.

Although vegetarians comprise only 3.3% of the American population, research suggests that this small population committed to the reduction of and exclusion of meat and animal products from the diet benefit from a significantly lower incidence of cardiovascular disease, hypertension, strokes, type 2 diabetes, and metabolic syndrome, fewer colorectal cancer diagnoses, potential improvement in mood and depressive and anxiety symptoms, and a lower all-cause mortality rate (Allen et al., 2018; Altzibar et al., 2018; Amiano et al., 2013; Appleby et al., 2013; Arroyave et al., 2020; Babio et al., 2010; Bazzano et al., 2002; Beeson et al., 2019; Bellavia et al., 2016; Bergkvist et al., 2004; Bernstein et al., 2013; Bernstein et al., 2012; BouÈ et al., 2019; Buthers et al., 2015; Decarli et al., 2017; Dekker et al., 2013; Devereux et al., 2017; Cross et al., 2009; International Agency for Cancer Research, 2015; Latella & Sasso, 2018; Micha et al., 2012). The dilemma of vegetarianism versus non-vegetarianism is particularly pressing today in the United States, a country that claims the impressive ranking of the fifth- highest per capita meat consumption in the world (Food and Agriculture Organization of the United States, 2015). Therefore, the potential dangers of high meat and animal product consumption on human health may fall particularly hard on the average, nonvegetarian American.

Types of Meat and Animal Products

Meat and animal products comprise a significant portion of the typical American diet. According to the United States Department of Agriculture (2020), Americans exceed the recommended dietary

amount of meats, eggs, and nuts. In the National Cancer Institute's 2014 dietary intake report, data indicates that in the United States, 76.8% of men over 19 years old and 50.2% of women over 19 consume more than the recommended amount of meat, poultry, and eggs (National Cancer Institute, 2014). Meat can be classified into two major categories: processed and unprocessed. The World Health Organization defines processed meat as meat that has undergone alteration from its natural state by cleaning, flavoring, pasteurizing, drying, heating, cooking, freezing, canning, smoking, salting, dehydrating, packaging, and/or other forms of manipulation to improve flavor and preservation (World Health Organization, 2015). The most common examples of processed meat include hot dogs, ham, sausages, beef jerky, corned beef, and meat-based preparations and sauces; most processed meats contain beef and/or pork (WHO, 2015). Red meat is typically defined as meat from mammalian muscle like beef, pork, veal, goat, lamb, mutton, and horse whereas white meat is more commonly associated with poultry and meats white in color (Bouvard et al., 2015; WHO, 2015). Poultry refers to chickens, ducks, geese, and turkeys and when used as a food category term, includes the use of these birds' meat and eggs for consumption. Dairy products are foods derived from milk that retain their calcium content like cheese, yogurt, and milk itself (USDA, n.d). Like meat, poultry, and eggs, dairy products are popular among Americans, with 11.4% of the population consuming more than the recommended dietary amount (National Cancer Institute, 2014). Understanding the classification of different types of meat helped organize the research process for the present review. Awareness of the current statistics on meat, poultry, and dairy consumption in the United States provide a clearer image of how most Americans eat today and puts the current findings on meat consumption and human health in perspective.

Animal-Based Diets and Cardiovascular Health

Contrary to the historical and cultural impression that meat consumption strengthens the human body, current research reveals that it may have detrimental effects on the cardiovascular system. According to the Centers for Disease Control and Prevention (2019), heart disease was the leading cause of death in the 2017 American population and deaths from cancer, strokes, and diabetes trail closely behind. Cardiovascular disease (CVD) claims 647,000 deaths in the U.S yearly; in other words, every one in four deaths is attributable to CVD and one American dies from CVD every 37 seconds (CDC, 2020a). Cardiovascular disease is an umbrella term for a wide range of heart conditions involving the blocking and narrowing of blood vessels and damaged or inhibited heart valves and muscles (Mayo Clinic, 2018). Narrowed blood vessels are problematic because the resulting decrease in blood flow to the heart may result in chest pain, strokes, and heart attacks, all of which are negative health outcomes that can have lasting damage on the heart (Mayo Clinic, 2018). Hypertension, high cholesterol, high blood sugar, and excess body fat are all components of poor heart health and are predictive of negative health outcomes (Mayo Clinic, 2019). Cardiovascular disease is highly prevalent in the American population, with 12.1% of American adults formally diagnosed with heart disease, 11.8% with high cholesterol, and 33.2% with hypertension (CDC, 2016). Together, heart disease and cancer accounted for almost half (44.7%) of all deaths in the United States in 2017 (CDC, 2019). Clearly, CVD poses a significant threat to Americans' quality of life and studies suggest that meat consumption may play a powerful role in this effect.

Red, Processed, and Unprocessed Meat Consumption and Cardiovascular Disease

Recent nutrition studies produce evidence that red meat and pro-

cessed meat intake increases risk for negative cardiovascular health outcomes (Appleby et al., 2013; Babio et al., 2012; Beeson et al., 2019; Bernstein et al., 2012; BouÈ et al., 2019; Devereux et al., 2017). According to Babio et al. (2010), high red meat intake corresponds with an increased risk for metabolic syndrome among people with cardiovascular disease risk factors. A Brazilian study on middle-aged men also found an increase in risk for metabolic syndrome in people who consumed higher amounts of red meat (Buthers et al., 2015). However, a Brazilian sample of participants may not accurately represent today's American population regarding general health status and dietary patterns. Metabolic syndrome refers to a handful of conditions that increase risk for heart disease, diabetes, and strokes. These conditions include high blood sugar, high cholesterol, abdominal obesity, and increased blood pressure (Mayo Clinic, 2019). Although Babio's research team (Babio et al., 2010) studied a population already at risk for cardiovascular disease, the findings are still meaningful for the American population given the nation's high rates of cardiovascular disease morbidity and mortality. The American population may not look very different from those at-risk participants used in Babio's study (2010). As stated, abdominal obesity is a crucial element of metabolic syndrome and is directly related to heart health. Vegetarian diets are associated with lower BMIs in many studies (Appleby et al., 2013; Beeson et al., 2019). For example, researchers who examined results from the Adventist Health Study II found that non-vegetarian participants were more likely to have a BMI higher than 30 kg/ than vegetarians (Beeson et al., 2019). Similarly, red meat consumption is associated with higher incidence of central obesity (Buthers et al., 2015). These findings speak volumes about cardiovascular health. Higher BMI and overweight and obesity states are associated with elevated risk of cardiovascular disease diagnosis and death; high BMI can even predict shorter lifespan (Allen et al., 2018; American Heart Association, 2014). A 2017 study found that people with hypertension who consume higher amounts of processed and unpro-

cessed red meat experience a significant increase in risk for atherosclerotic plaques, which contribute to narrowing of the heart vessels and therefore strokes and heart attacks (Devereux et al., 2017). Given that 33.2% of the American population has hypertension, Devereux's findings have important implications for the hypertensive community and those who care for them. Eating meat and animal products appears to increase the risk for and prevalence of the very risk factors that predispose people to cardiovascular disease. However, people with risk factors for CVD are not the only population vulnerable to the negative cardiovascular effects of meat consumption.

In 2012, nutrition and epidemiology researchers Bernstein and colleagues conducted two prospective cohort studies and analyzed results from 121,342 participants to understand the relationship between red meat consumption and cardiovascular disease, cancer, and mortality. They found that people who consumed more processed and unprocessed red meat had significantly higher risk for cardiovascular disease, cancer, and total mortality (Bernstein et al., 2012). The researchers calculated that one serving a day of unprocessed red meat increased risk of death by 13% and one serving a day of processed red meat increased risk by 20% (Bernstein et al., 2012). Participants who regularly consumed unprocessed and processed red meat were more likely to die of cardiovascular disease than those who did not consume red meat. Hot dogs and bacon were found to be particularly dangerous regarding overall mortality compared to other meat products. These findings are not unique. A Swedish study published in the *American Journal of Clinical Nutrition* reports that of its 74,645 participants, those who consumed the highest amounts of red meat had a 29% increased risk of cardiovascular disease mortality and 21% increased risk for overall mortality (Bellavia et al., 2016). Researchers who studied 17 prospective cohorts found higher risk of cardiovascular disease mortality in participants who consumed higher amounts of red meat and processed meat compared to those who consume lower

amounts or no meat (Hu et al., 2016). Likewise, a 2015 study that examined 34,057 women discovered that participants who consumed more than 50 grams of red processed meat a day had a significantly higher risk for heart failure than those who consumed less than 25 grams a day (Kesson et al., 2015). Furthermore, a 2009 study that analyzed 545,653 adults, found an increased risk of total mortality, cancer mortality, and CVD mortality among participants who consumed higher amounts of red meat and processed meat (Cross et al., 2009). Interestingly, these researchers found an increased risk of death from accidents and injuries in only men who consumed higher amounts of red meat (Cross et al., 2009). This increase in risk of death from injuries was not detected in men consuming high amounts of processed meat or women consuming high amounts of processed meat or red meat. This finding seems to suggest an association between high red meat consumption and increased risk for dying from injuries among men but why this association exists is currently unknown and worthy of further research. It is becoming increasingly clear that meat consumption increases risk for negative cardiovascular outcomes like hypertension, atherosclerotic plaques, narrowing of the blood vessels, and heart disease both in people with pre-existing cardiovascular disease risk factors and those without.

White Meat Consumption and Cardiovascular Disease

Poultry and fish are considered ‘white meat’ because they are white in color and contain less myoglobin. Unfortunately, there is limited research on the effects of white meat consumption on cardiovascular health. White meat is often studied in conjunction with red meat rather than analyzed on its own. Only four studies met the criteria for inclusion in the present research process. The research, albeit limited, suggests that white meat consumption has a weaker connection to increased negative cardiovascular outcomes and all-cause mortality compared to red meat. According to Greenland et al. (2020), a study that examined dietary patterns and health outcomes in 29,683

American adults, poultry intake *does* in fact increase risk for cardiovascular disease incidence mortality, but only slightly. Cross et al. (2009) also found a slight increase in cardiovascular disease mortality among men who reported higher intake of white meat. This information is significant because Cross's research team used 545,653 participants for analysis, making the team's findings incredibly powerful. It appears that white meat consumption is linked to increased risk of cardiovascular disease incidence and mortality but not to the same degree as red meat consumption. A 2015 study analyzing the relationship between meat intake and metabolic syndrome unsurprisingly found a strong association between red meat consumption and metabolic syndrome but did not detect this association between white meat intake and metabolic syndrome (Buthers et al., 2015). Some studies indicate there is no association between white meat and increased risk for all-cause mortality (Amiano et al., 2013; Greenland et al., 2020). In fact, according to Amiano et al. (2013), low consumption of white meat is associated with increased risk for all-cause mortality. Cross et al. (2009) also found an inverse relationship between white meat consumption and increased risk for all-cause mortality. This research implies that not consuming enough white meat might increase risk for all-cause mortality or at least that consuming white meat in moderation might improve mortality outcomes. Collectively, current research suggests that high white meat consumption may slightly increase risk of cardiovascular disease incidence and mortality. People who consume less white meat appear to have a slightly lower risk of CVD and CVD death, however, some studies indicate that low consumption of white meat is linked to increased risk for all-cause mortality. More research is needed on the relationship between white meat consumption and cardiovascular disease and total mortality.

Research suggests that fish consumption is associated with positive cardiovascular outcomes with very few conflicting results, thus fish intake is discussed separately from white meat intake. Many

studies find no association between fish consumption and negative cardiovascular disease outcomes, strokes, or increased total mortality (Beulens et al., 2018; Buring et al., 2016; Greenland et al., 2020). Furthermore, some researchers report finding an inverse relationship between high fish intake and negative cardiovascular health outcomes. A study published in the *Journal of Internal Medicine* analyzed 421,309 people and 6.07 million person-years of follow up to better understand the relationship between fish consumption and various causes of death (Abnet et al., 2018). The researchers compared participants based on highest and lowest quintiles of fish consumption and discovered that women in the highest quintile of consumption benefited from an 8% decreased total mortality, 10% decreased CVD mortality, and 38% lower risk of developing Alzheimer's disease (Abnet et al., 2018). The study's male participants appeared to have even more benefits from high fish intake including a 9% lower all-cause mortality rate, 10% lower CVD death rate, 6% lower risk of dying from cancer, 20% lower respiratory disease death rate, and a 37% decreased death rate from chronic liver disease (Abnet et al., 2018). This study's large sample size makes its findings unusually powerful. An Iranian study found significant differences in results between male and female participants as well. Dierkes et al. (2017) found fatty fish intake to be linked to lower triglyceride levels in men only and lean fish intake linked to lower triglyceride levels in women only. These two studies suggest there are potential differences in how men and women process and utilize the cholesterol in fish. According to Arcari et al. (2017), four or more servings of fish a week is linked with a 40% lower risk for coronary heart disease and strokes among 20,969 Italian adults. These Italian researchers note that fatty fish in particular appeared to be the driving force between this inverse relationship between fish consumption and negative cardiovascular outcomes (Arcari et al., 2017). Another Italian study conducted in 2014 reports a higher prevalence of carotid atherosclerosis in people who consume low amounts of fish, however the authors note they are un-

sure of to what degree this effect is attributable to age rather than dietary intake (Belmonte et al., 2014). A Chinese study on 134,296 adults found an inverse relationship between fish intake and risk for diabetes, ischemic stroke, and total mortality and reported no association between fish intake and ischemic heart disease mortality and cancer (Cai et al., 2013). Beulens et al. (2018) confirms: more than one serving a week of lean and fatty fish each is associated with a significantly decreased incidence of ischemic stroke. Nutrition researchers also find a lower incidence of metabolic syndrome among people who consume higher amounts of fish (Barak et al., 2014; Dierkes et al., 2017). The authors of Barak et al. (2014) claim that women with the highest fish consumption in their study displayed a 65% lower risk for developing metabolic syndrome. Dierkes et al. (2017) found lower incidence of metabolic syndrome among men who consume high amounts of fish as well and report a positive relationship between fish consumption and HDL cholesterol levels in both men and women. The research on fish consumption and cardiovascular health outcomes is unquestionably clear. Eating fish is not associated with negative cardiovascular outcomes. Fish decreases risk for cardiovascular disease mortality, cancer mortality, total mortality, diabetes development, strokes, and other negative health outcomes. It appears that fish is an important and protective food that should be included in the human diet.

Dairy Products and Cardiovascular Disease

Many vegetarians exclude dairy from their diet for numerous reasons, one being to protect health. However, a 2017 meta-analysis of 29 prospective cohort studies refutes any association between high-fat dairy (whole milk and cream), low-fat dairy, (low fat milk, cheese, and yogurt), and milk intake with increased risk for cardiovascular disease (Astrup et al., 2017). Moreover, intake of fermented dairy like yogurts, cheeses, and sour cream, appeared to show a weak inverse association with cardiovascular disease, meaning intake of this food

type may decrease risk of heart disease (Astrup et al., 2017). However, when the authors excluded one study in particular from their analysis, this inverse association disappeared. A different research team studying people already at risk for cardiovascular disease discovered that women who consumed additional dairy products in conjunction with a Mediterranean diet experienced lower morning blood pressure, higher HDL cholesterol levels, and lower triglyceride levels over an eight-week period (Davis et al., 2018). This is an interesting finding because it suggests that dairy consumption might help slow the process of cardiovascular disease and protect those with it from suffering worsening symptoms. An inverse association between dairy consumption and negative health outcomes is not a unique finding to this study. An Iranian study found that among randomly selected participants, total dairy intake actually decreased risk for metabolic syndrome; when low fat dairy and high fat dairy were studied separately, this inverse association disappeared but there was no increase in risk for metabolic syndrome (Akhaven-Tabib et al., 2020). Interestingly, these researchers also note an inverse relationship between total dairy intake and triglyceride levels, waist circumference, and systolic blood pressure and improvements in HDL cholesterol level (Akhaven-Tabib et al., 2020). A 2014 study on healthy, French-Canadian individuals revealed an inverse relationship between dairy consumption and fasting plasma glucose level and systolic and diastolic blood pressure (Da Silva et al., 2014). Despite these findings, a 2013 study on a healthy, Dutch population reports that while overall dairy intake does not increase risk for CVD, high-fat dairy consumption increases risk of cardiovascular disease by 32% (Dekker et al., 2013). These researchers used 2,484 healthy participants free of cardiovascular disease and its risk factors at baseline; they defined high-fat dairy products as milk containing more than 2.0 grams of fat per 100 grams of product and cheese containing more than 20 grams of fat per 100 grams of content. To further add to this wealth of conflictual research, a 2018 study published in *The American Journal of Clinical Nutrition* suggests

no association between circulating biomarkers of dairy fat (including phospholipid pentadecanoic, heptadecanoic, and trans-palmitoleic acid) and cardiovascular disease incidence or death (de Oliveira Otto et al., 2018). In fact, high levels of heptadecanoic acid were found to decrease the risk of death from cardiovascular disease and stroke (de Oliveira Otto et al., 2018).

There is notably more conflictual data on dairy consumption and cardiovascular health than there is on meat consumption and cardiovascular health. Nonetheless, the majority of studies examined for the present research project found no evidence of an association between dairy consumption and cardiovascular health. Some research suggests that intake of high-fat dairy increases risk for cardiovascular disease and overall mortality, but the evidence is limited. Many sources declare an inverse relationship between dairy consumption and glucose levels, triglycerides, and blood pressure, especially among those with cardiovascular disease diagnoses and/or risk factors. This suggests that dairy consumption may help to slow the damage caused by pre-existing heart disease. Despite the notably less than unanimous nature of these findings, the research on dairy consumption is still incredibly valuable. Those susceptible to and with cardiovascular disease may benefit from a conversation with their providers about increasing their dairy intake. Individuals with high blood pressure might experience improvements in both systolic and diastolic blood pressure should they try supplementing meat with dairy products.

Egg Consumption and Cardiovascular Disease

Known for their abundant supply of protein and cholesterol, eggs are exceptionally popular among Americans (United Egg Producers, n.d). American egg consumption has risen 16% in the last 20 years and many lacto-ovo and ovo-vegetarians enjoy eggs regularly alongside nonvegetarians (United Egg Producers, n.d). The scientific verdict on the healthfulness of eggs has swung back and forth over the

years. Analysis of the current literature on egg consumption followed a similar suit, however, the research process for the present project revealed notably more studies confirming the absence of or an inverse relationship between egg consumption and negative cardiovascular outcomes than those finding fault with eggs. Numerous studies conducted in the last decade found that egg consumption, even in the highest amounts, is not associated with increased incidence of or death from cardiovascular disease (Agudo et al., 2019; AlHabib et al., 2020; Benito et al., 2011; Cheng et al., 2019; Cockcroft et al., 2018; Jang et al., 2018). In fact, some researchers believe that egg consumption may lower risk. In a study including over 18,000 participants, higher egg intake was found to be negatively linked to BMI, blood pressure, LDL cholesterol, triglyceride level, and overall cholesterol (Cheng et al., 2019). These findings, particularly those concerning cholesterol, are shocking because eggs are known for their high cholesterol content. Nonetheless, AlHabib et al. (2020) confirms no association between egg consumption and significant change in blood lipids. According to Bian et al. (2018), a study that analyzed questionnaires and medical registries of 512,891 Chinese adults, consuming an estimated 5.32 eggs per week was associated with a 12% lower risk of acquiring ischemic heart disease (Bian et al., 2018). Cheng et al. (2019) confirms no increase in deaths from ischemic heart disease among people consuming eggs. However, Bian's research team defined "daily consumption" as up to one egg a day, which may be much lower than what most Americans consume per day. Cockcroft et al. (2018) were able to extract and study the risk of myocardial infarction in regard to egg consumption; the team found no association between these two variables.

Many of the studies analyzed focused their research on cardiovascular health but included incidence and death from cerebrovascular accidents (CVAs) or strokes. According to Cockcroft et al. (2018), egg consumption is not associated with increased risk for strokes, ho-

wever, other research claims eggs decrease the risk for stroke. When Cheng's 2019 research team conducted a meta-analysis and included their own findings in the analysis, they found that intake of seven or more eggs a week was linked with a slight reduction in risk for stroke (Cheng et al., 2019). Bian et al. (2018) were able to enumerate the decreased risk in hemorrhagic stroke by 28% in those who consume eggs on the daily. In regard to overall mortality, numerous studies indicate that unlike meat consumption, eating eggs even in high amounts, is not linked with higher risk of all-cause mortality (Agudo et al., 2019; AlHabib et al., 2020; Cheng et al., 2019; Cockcroft et al., 2018). In fact, in a 2018 study by Agudo and colleagues (2019), egg consumption was found to be inversely associated with deaths from other causes like nervous system disorders (Agudo et al., 2019). Although the collective findings from the current literature on egg consumption and cardiovascular outcomes is incongruent with expectations, there is a strong argument for the inclusion of eggs in the human diet. It appears that eggs are not only not associated with negative cardiovascular outcomes but might help protect against strokes and poor heart health. The present evidence notwithstanding, some research disputes these findings and these studies are equally worthy of consideration.

An American study published in *JAMA Cardiology* by nutrition and medical researchers analyzed 29,615 adults recruited in six prospective cohort studies in the hopes of clarifying the relationship between egg consumption and cardiovascular health (Allen et al., 2018). Unlike the aforementioned research, this study found that every additional half an egg eaten per day is significantly linked with higher incidence of cardiovascular disease and all-cause mortality (Allen et al., 2018). This association remained statistically significant even when researchers adjusted for cardiovascular disease risk factors. This study is particularly interesting because the team notes in their report that the association between egg consumption and cardiovascular dis-

ease and overall death became insignificant when they adjusted for processed red meat and unprocessed meat consumption (Allen et al., 2018). In other words, it is unclear whether it is the cholesterol from eggs or meat that results in the increase in CVD and total mortality. The researchers make the unique point that there is little knowledge of how the combination of meat and egg intake may affect cardiovascular health. The interaction between eggs and meat in the human body and the health effects it may generate would be an excellent topic for further research.

After thorough consideration of the current literature on egg consumption and cardiovascular health, it is concluded that eggs are likely not detrimental to cardiovascular health but should be consumed in moderation, nonetheless. Many studies negate an association between egg consumption and cardiovascular disease, strokes, and total mortality and some suggest eggs might reduce risk of stroke, which is particularly valuable information for those at risk for cerebrovascular accidents. However, in the name of strong, objective research and critical thinking, studies finding a positive association must not be dismissed out of convenience. A team of researchers found a positive association between egg intake and negative cardiovascular outcomes (Allen et al., 2018). After analyzing this study's report, no major limitations or flaws in design were noted and thus, this research remains valuable to the present cause. The mixed research on how eggs affect human health suggests a need for more high-quality research to be conducted, particularly on how eggs and meat interact in the human body to affect the heart and other organs. The studies mentioned thus far were conducted from the perspective of examining the association between meat, dairy, and egg consumption and cardiovascular health. Other researchers have chosen a different approach: analyzing the association between vegetarian diets and improved cardiovascular health. The search for clarity in this domain yielded intriguing results.

Vegetarianism and Cardiovascular Health

A study published in 2019 by Loma Linda University nutrition researchers found that vegetarians have significantly fewer cardiovascular disease risk factors and cardiovascular disease diagnoses than nonvegetarians (Beeson et al., 2019). The team organized their 650 participants based on diet into four categories including vegans, lacto-ovo vegetarians, pesco-vegetarians, and non-vegetarians. They found that vegetarians, lacto-ovo vegetarians and vegans in particular, were less likely to have hypertension, obesity, abdominal adiposity, and high cholesterol than nonvegetarian participants (Beeson et al., 2019). Among the vegetarians, vegans had the lowest prevalence of hypertension (Beeson et al., 2019). These findings suggest that the foods that vegetarians choose to consume (and not consume) over time, protects the body from negative cardiovascular effects that non-vegetarians more frequently experience. Interestingly, the researchers also found that women who fell into any of the vegetarian categories had a lower prevalence of obesity and abdominal adiposity, however, for men this decrease in prevalence was only statistically significant among men who were lacto-ovo vegetarians (Beeson et al., 2019). This hints to seemingly inherent gender differences in the bodies' responses to vegetarian diets and is worthy of further research. It is important to note that Beeson and colleagues analyzed data from non-Hispanic Caucasians rather than including a more diverse study group, a research decision that may inhibit the representativeness of their sample. However, the researchers note that their findings were similar to those found among African American participants in a sister study. The inverse relationship between vegetarian diets and cardiovascular disease is a growing pattern in today's nutrition and health studies.

British researchers Appleby, Crowe, Key, and Travis (2013) gathered data from 44,561 people residing in England and Scotland participating in the EPIC-Oxford Cohort Study to better understand

how vegetarian diets affect and protect heart health. The vast majority of the vegetarian participants were female (76%), younger in age, and less likely to smoke than their nonvegetarian counterparts who typically consumed more alcohol and had higher BMIs than the vegetarians (Appleby et al., 2013). The researchers note that vegetarian participants consumed more fruits, vegetables, and whole grains than nonvegetarians and had significantly lower overall cholesterol (Appleby et al., 2013). Although there were no statistically significant differences in diastolic blood pressure, the vegetarians had notably lower systolic blood pressure by 3.3 mmHg (Appleby et al., 2013). Furthermore, vegetarians had a 32% decreased risk of ischemic heart disease, also known as coronary artery disease which involves hardening of the arteries, compared to nonvegetarians even after accommodating for demographic and social factors such as physical activity, education level, and age (Appleby et al., 2013). Thus, vegetarian diets are increasingly associated with more positive cardiovascular outcomes than nonvegetarian diets and appear to have protective effects on the heart. For example, Bernstein's research team calculated that replacing one serving of unprocessed red meat with fish, poultry, nuts, legumes, low-fat dairy items, and whole grains decreased risk for overall mortality by 5%, 13%, 18%, 8%, 9%, and 13% respectively (Bernstein et al., 2012). Replacing one serving of processed red meat with these vegetarian foods decreased risk of death even further: by 10% for fish, 17% for poultry, 22% for nuts, 13% for legumes, 13% for low-fat dairy products, and 16% for whole grains (Bernstein et al., 2012). These findings are very meaningful for nutrition and human health and should play a role in personal decisions regarding both diet and overall health.

Valued for its rich protein stores, meat comprises a large portion of many Americans' daily diets, however for such an excellent source of protein, animal product consumption is associated with higher body mass index (BMI), cholesterol, blood sugar, and blood pressure

and increases risk for metabolic syndrome, cardiovascular disease, and death from cardiovascular disease (Babio et al., 2010; Beeson et al., 2019; Bernstein et al., 2012; BouÈ et al., 2019; Devereux et al., 2017). At various stages in this project's research process, studies failing to find an association between meat consumption and negative cardiovascular outcomes were discovered. It is important to note the existence of these studies, however such studies often had at least one major limitation that casts doubt on the accuracy and power of results, such as a sample size of only 37 participants or the researchers' decision to study a population that had statistically low meat consumption at baseline (Clarke et al., 2019; Lee et al., 2018). Not only is meat consumption contributory to negative cardiovascular health outcomes, but vegetarian diets are found to improve and protect cardiovascular health and may ward off chronic heart conditions more frequently experienced by meat-eaters (Appleby et al., 2013; Beeson et al., 2019; Bernstein et al., 2012). Increasing fruit, vegetable, and whole grains consumption and decreasing meat intake may lower the United States' record high levels of cardiovascular disease mortality and morbidity.

Animal-Based Diets and Type 2 Diabetes Mellitus

Type 2 diabetes mellitus is an endocrine disorder in which the body is unable to move glucose, a dietary sugar necessary for cell function, into body cells where it is needed. As a result, glucose accumulates in the blood, a phenomenon known as 'hyperglycemia.' The combination of low glucose in the cells and excess glucose in the blood causes numerous symptoms like fatigue, weight loss, itching, and tingling sensations as well as serious health effects like blurred vision, nerve damage, abdominal pain, impaired wound healing, recurrent infections, necrosis, and other life-threatening complications. This disease does have a genetic etiology, however lifestyle factors like being overweight, low physical activity, and poor diet also play an important role in diabetes (Centers for Disease Control and Prevention,

2020b). According to the American Diabetes Association, 10.5% of the population has type 2 diabetes and in 2017, this disease was named the 7th leading cause of death in the U.S (American Diabetes Association, n.d). Not unlike cardiovascular disease, type 2 diabetes is both prevalent, deadly, and undoubtedly harmful to the quality of life of its sufferers. Diabetes increases risk for developing other serious conditions like coronary artery disease, hypertension, and dyslipidemia as well as increases risk for having a cerebrovascular accident (Cheever & Hinkle, 2018). Thus, type 2 diabetes is undeniably linked to cardiovascular health and recent research indicates that meat consumption and vegetarianism may impact the development of type 2 diabetes.

Meat Consumption and Type 2 Diabetes

The link between diabetes and cardiovascular diseases leads to concern that the negative heart effects caused by high meat intake may intensify among the diabetic population. After analyzing results from three cohorts of American adults, researchers Bernstein, Hu, Manson, Pan, Schulze, Sun, and Willett (2013) found a strong link between processed and unprocessed meat consumption and type 2 diabetes. In 2012, researchers Micha, Michas, and Mozaffarian analyzed seven cohort studies and found a 19% increase in risk of type 2 diabetes for every 50 grams of processed meat eaten per day (Micha et al., 2012). A prospective cohort study based in Hawaii found that red and processed meat consumption is associated with increased incidence of type 2 diabetes (Erber et al., 2011). These researchers found a slight increase in risk for type 2 diabetes with processed poultry intake and no association between fresh poultry and type 2 diabetes (Erber et al., 2011). There is little research on white meat consumption and type 2 diabetes, however, according to Engeset et al. (2014), lean fish intake is associated with decreased risk for type 2 diabetes. The researchers found no evidence of an association between fatty fish, fish products, cod liver oil supplements, or total fish intake and

type 2 diabetes (Engeset et al., 2014). Azadbakht et al. (2019a) also found no association between fish or fish product intake with increased risk for type 2 diabetes. It is becoming increasingly clear that eating meat and animal products is harmful not only to the cardiovascular system, but to the body's endocrine system as well. Fish intake protects the body from type 2 diabetes; thus, fish should be readily included in the diets of people predisposed for this condition.

Dairy and Egg Consumption and Type 2 Diabetes

Numerous recent studies claim there is no link between eating dairy products and developing type 2 diabetes (Brouwer-Brolsma et al., 2016; Chen et al., 2014). In fact, many researchers report an inverse relationship between dairy products, particularly yogurt, and type 2 diabetes incidence (Azizi et al., 2015; Babio et al., 2016; Haffner et al., 2014; Koh et al., 2018). According to Chen et al. (2014), a study that followed 41,436 participants, yogurt consumption is linked with lower incidence of diabetes. Babio et al. (2016) confirms these findings: in Babio's study, participants who regularly consumed dairy yogurt had a 40% lower incidence of type 2 diabetes. These findings remained true even for whole fat yogurt. Ding et al. (2019) found an increase in yogurt consumption by half a serving a day to decrease risk for type 2 diabetes by 11%. Ding's study is especially interesting because the researchers claim to have found a moderate increase in risk for type 2 diabetes among people who consume cheese, but maintain that yogurt decreases risk (Ding et al., 2019). This suggests that yogurt is different compared to other dairy products in that it may help to prevent type 2 diabetes, but this finding was not consistent across all studies. Milk was occasionally found to have an inverse relationship with type 2 diabetes, but this finding was not reliably and consistently found in other studies. According to Babio et al. (2016), total and low-fat milk consumption is linked to lower risk of type 2 diabetes. However, after adjusting for potential confounders, this association disappeared for total fat milk consumption

but remained strong between low-fat milk and type 2 diabetes (Babio et al., 2016). Koh et al. (2018), report that milk intake reduces risk for type 2 diabetes by 12%. Interestingly, another team of researchers found the inverse relationship between milk consumption and type 2 diabetes to exist only for men. Azizi's 2015 research team found a 41% decrease in type 2 diabetes risk for every positive increment of 100 grams per day of milk for men even in a fully adjusted model. Collectively, these findings were contradictory to the expected results. The research suggests that including dairy in the human diet is not strongly associated with type 2 diabetes development and in fact, some dairy products (notably yogurt and possibly milk) may help prevent this disease.

Regarding the effects of egg consumption on development of type 2 diabetes, the research is mixed. According to Cockcroft et al. (2018), Burkholder-Cooley et al. (2018), and Jang et al. (2018), egg consumption is not associated with diabetes. In a study analyzing how egg consumption affects people with type 2 diabetes, it was found that eggs didn't change cholesterol or cause adverse effects (Baqleh et al., 2015). According to Mursu et al. (2015), egg consumption actually lowers incidence of type 2 diabetes by 38% among men. However, other sources offer conflicting data. Cockcroft et al. (2018) found egg consumption among diabetics to be linked to higher plasma glucose, a phenomenon certainly not helpful to individuals with high blood glucose. Likewise, Korean researchers have found no association in those without diabetes, but in those with the disease, egg consumption increases risk for cardiovascular disease by 2.8 times in diabetics who eat 4.2 eggs a week (Jang et al., 2018). These findings suggest that egg consumption among healthy individuals does not increase risk for type 2 diabetes, however, people who have diabetes might consider avoiding eggs due to their apparent association with worsening diabetic symptoms and cardiovascular disease.

Vegetarianism and Colorectal Cancer

According to the American Cancer Society, colorectal cancer is the third most frequently diagnosed cancer in the United States and is expected to claim an estimated 53,200 deaths in 2020 alone (American Cancer Society, 2018b). Recent research reveals useful discoveries on the growing association between animal product consumption and colorectal cancer. Studies indicate a strong, positive association between meat consumption and colorectal cancer (Altzibar et al., 2018; Arroyave et al., 2020; Bergkvist et al., 2004; Decarli et al., 2017; International Agency for Cancer Research, 2015; Latella & Sasso, 2018). People who develop colorectal cancer are more likely than non-cancer patients to be heavy consumers of processed and unprocessed meat (Arroyave et al., 2020). In a 2017 nutrition study, participants who regularly consumed the highest amounts of processed meat had a 40% increased risk for colorectal cancer compared to others (Decarli et al., 2017). These researchers found a strong relationship between processed meat consumption and cancers of the proximal colon specifically which includes the appendix, ascending colon, transverse colon, caecum, and hepatic flexure (Decarli et al., 2017). Other studies show that meat consumption increases risk elsewhere in the colon as well. A 2004 Swedish study found high consumption of red meat, particularly beef and pork, to double the risk of distal colon cancer (Bergkvist et al., 2004). Many studies analyzed focused on the effects of particular types of meat, such as processed or unprocessed red meat, however a 2018 study conducted by Spanish researchers studied a wide range of meat and found that consumption of all meat, including white, red, processed, cured, and organ meats, significantly and statistically increases risk for development of colorectal cancer (Altzibar et al., 2018). Furthermore, the way meat is prepared and cooked also seems to affect its carcinogenicity to the human gastrointestinal system. People who enjoy their meat grilled, barbecued, and/or griddled are more likely to develop colorectal cancer than

people who prefer meat rare (Altzibar et al., 2018; Arroyave et al., 2020). Fortunately for pescovegetarians, fish consumption does not appear to be associated with increased risk for colorectal cancer (Bergkvist et al., 2004). As with almost all research, there are current studies that fail to identify an association between meat consumption and colorectal cancer, however, as with cardiovascular studies, these studies often involve at least one major limitation. In 2015, the International Agency for Research on Cancer released a statement announcing red meats' "probably carcinogenic" and processed meats' definitively "carcinogenic" effects on humans (International Agency for Research on Cancer, 2015). Not only is meat consumption associated with colorectal cancer, but vegetarianism itself is linked with lower colorectal cancer risk (Beeson et al., 2019; Dagnelie et al., 2015; Hahn et al., 2013). A healthy vegetarian diet may be a useful and nourishing alternative to meat consumption for those more vulnerable to cancer, those with cancer, and those simply determined to live a healthier life.

Vegetarianism and Mental Health

Although the meaning of a good, happy life may vary by person, it is reasonable to expect that happiness and health are not singularly dependent on physical health, but also on the environment within the human mind. Nutrition is often considered and studied in regard to the human body systems. As explained previously, the exclusion of meat from the human diet (vegetarianism) improves cardiovascular health, protects against colorectal cancer, lowers type 2 diabetes incidence, and lower risk of all-cause mortality. These findings are important to nutrition researchers and health-conscious individuals alike. However, vegetarianism and mental health, including that of mood and general happiness, is a topic relatively unexplored. Given the damage meat consumption can wreak on the body of a healthy human, it is not only interesting but imperative that we understand

how diet can affect the mind as well.

Review of the current research on vegetarianism and mental health revealed an unfortunate scarcity in studies on this essential topic. Seven studies were selected for analysis based on their relevance. Interestingly, some studies indicated an association between vegetarian diets and elevated occurrence of mental disorders (Jacobi et al., 2012; Lavallee et al., 2019). According to Jacobi et al. (2012), vegetarians show increased prevalence of depressive, anxiety, and somatoform disorders. This is not to say that vegetarian diets themselves increase risk for mental disorders; Jacobi's research team found that on average, adoption of a vegetarian diet occurred after the onset of the mental disorder. Therefore, it is improbable that vegetarian diets are responsible for the development of mental disorders. Instead, it seems that people with mental disorders like anxiety and depression may harbor personality and/or disorder traits that make them more likely to become vegetarian, a topic worthy of further investigation. Cross sectional and longitudinal analysis of university students in Germany, Russia, the United States, and China found no association between vegetarian diets and positive or negative mental health but did find that Chinese students who were vegetarian were more likely to experience increased anxiety and depression (Lavallee et al., 2019). This association was not found among the American, Russian, or German students and the confounding factors of Chinese culture and student-status may have affected results. Fortunately, the current available research is not entirely negative for vegetarian diets and mental health. Some studies indicate that eating a healthy vegetarian diet decreases anxiety, depression and stress (Beezhold et al., 2015; Azadbakht et al., 2019b; Chen et al., 2020). According to Azadbakht et al. (2019b), a study that examined 435 Iranian women, those with high plant-based diets and healthy plant-based diets scored lower on depression, anxiety, and psychological distress scales. Furthermore, researchers gathering data via surveys found that vegetarians report

significantly better mood than nonvegetarians and vegans report less anxiety and stress than nonvegetarians (Beezhold et al., 2015). Naturally, the self-reporting nature of surveys introduces doubt to the findings and there are innumerable confounding variables that may improve mood and decrease stress and anxiety in vegetarians and vegans that are entirely unrelated to their diet. These considerations notwithstanding, there is more evidence that depressive and anxiety symptoms may be decreased in vegetarians. A study on adolescents in low and middle income countries found that consumption of less than five fruits and vegetables a day is linked to increased anxiety and depression symptoms in teenagers (Chen et al., 2020) Fruit intake was associated with lower incidence of depressive and anxiety symptoms while vegetable intake was found to be linked to lower depressive symptoms only (Chen et al., 2020). This data is particularly compelling because it suggests that fruits and vegetables may play a role in mood. In their 2012 randomized controlled trial study, researchers Beezhold and Johnston recruited 39 participants, organized them based on diet, and administered standardized mood scales including the Depression Anxiety Stress Scales (DASS) and the Profile of Mood States (POMS) questionnaire at regular intervals. They found that vegetarians showed significant improvement on the Depression Anxiety Stress Scale after two weeks of dietary intervention, indicating that people who avoid poultry, fish, and meat, may display better moods than those who do not (Beezhold & Johnston, 2012). While this research provides hope for positive effects of a healthy, plant-based diet, it is important to consider that this study used only 39 participants and relied on participants' self-report of mood.

Clearly, further research is needed in the domain of vegetarian diets and mental health. Some research indicates an association between vegetarian diets and mental disorders, however no studies analyzed could find a causal relationship between these variables. Studies suggesting a link between plant-based diets and depression and anx-

ity often had at least one major limitation. Some research indicates that vegetarian diets are associated with decreased stress, anxiety, and depressive symptoms, but due to the inherent nature of evaluating these variables via self-reports, these conclusions must be considered with caution. Because self-reports are somewhat necessary in evaluating mood and stress and depressive and anxiety symptoms, it might be beneficial to the power and accuracy of future research to include family and friend reports of participants' perceived mood, stress, and other symptoms. This might allow researchers to gain a more balanced and well-rounded view of participants' true moods in relation to their diet.

Conclusion

To answer the question of how meat consumption and plant-based diets respectively affect human health, thorough research was conducted mainly from the perspective of how meat, dairy, egg, and fish consumption affects health. This strategy was used because meat, dairy, eggs, and fish are the foods commonly excluded from the vegetarian diet. By studying the health effects of these foods in people who consume moderate to high amounts of them, a clearer image is formed of the health effects vegetarians avoid by reducing and/or excluding these foods. Cardiovascular disease, cancer, diabetes, and strokes are the leading causes of death in the United States and according to the present research, a large proportion of these deaths may be prevented by changes in diet. Red meat, processed meat, and unprocessed meat consumption is strongly and undeniably linked to cardiovascular disease incidence and mortality, metabolic syndrome, hypertension, type 2 diabetes, colorectal cancer incidence and mortality, and increased all-cause mortality among both clinically unhealthy and healthy people alike. More research is needed on how white meat, eggs, and dairy impact human health, however, many studies find no association between egg and dairy consumption and negative health outcomes in healthy people. Plant-based diets offer protection

from cardiovascular disease incidence mortality and colorectal cancer, are associated with lower BMI, and may improve mental health. After thorough consideration of all the research studied, it is concluded that a lacto-ovo-pesco vegetarian diet with low to moderate dairy and egg intake may provide the best balance of protection from negative health outcomes and proper and complete nourishment. Many farms produce cage-free eggs and dairy using humane strategies that involve fair and healthy treatment of their animals and thus it is possible to consume dairy and egg products without involving oneself in the cycle of animal cruelty. Individuals should supplement the necessary nutrients often missing from a vegetarian diet, such as iron, to ensure they are properly nourished. It is essential that people understand how foods affect their bodies and lives. More work is needed to circulate this nutritional knowledge among the general population by public health, healthcare, and nutrition professionals. Thus, nutrition education is crucial to lowering the staggering number of American deaths from heart disease, cancer, strokes and diabetes and to promoting longer and healthier lives.

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