

**The Effects of the Vegetarian Diet on Adult Body Composition and Obesity in the
United States**

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Honor Thesis Paper

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The focus of this literature review is to examine the effects of the vegetarian diet on adult body composition and obesity in the United States (US). The vegetarian diet is a plant-based diet, which, when well-planned, can provide not only a sufficient dietary intake, but beneficial health effects (Cramer et al., 2017). Research has demonstrated beneficial effects of the vegetarian diet on body composition and body mass index (BMI), which is one measure used to assess obesity (Melina et al., 2016; Smith, et al., 2000; Garabed, 2008).

However, there have been reports of nutritional deficiencies associated with the vegetarian diet which must be investigated (Shurtleff, 1983; Craig, 2010). It is important to explore and have a better understanding of how the vegetarian diet affects adult body composition and obesity, particularly regarding health benefits and risks (Melina et al., 2016).

History of the Vegetarian Diet

The history of the vegetarian diet has been traced back to ancient religions and philosophies (*Vegetarianism and meat-eating in 8 religions*, 2021). As an example, the beliefs and practices of Jainism, an ancient religion in India, included vegetarianism. During the 9th century BC, Jains believed that one should not harm even the simplest forms of life, such as cows, chickens, and some plants (*Vegetarianism and meat-eating in 8 religions*, 2021). Religious scriptures, referred to as the Jain Agam, describe the mandatory rules Jains followed regarding vegetarianism, based on the principle of nonviolence or ahimsa. From that time on, the Jains have remained steadfast in this way of life.

In addition, there have been other ancient religions in India, such as Hinduism and Buddhism, that have promoted a vegetarian diet (*Vegetarianism and meat-eating in 8 religions*,

2021). Although it is not a requirement for those following the Hindu religion, many Hindus feel that being vegetarian enhances spiritual life and is also consistent with the principle of ahimsa. Regarding Buddhism, Buddha, its founder who lived in ancient India, was opposed to the slaughtering of animals, and inspired those who followed him to do the same. Buddha's teachings included three rules surrounding the consumption of meat; these rules were to not eat meat if they saw the animal being killed; if they consented to its slaughter; or if they knew the animal was being killed for consumption (*Vegetarianism and meat-eating in 8 religions*, 2021). Buddhism promotes the value of life for all living things, both humans and animals included.

Though there is no exact historical data at this time, it appears that the earliest documents on the vegetarian diet were written around the 6th century BC by another religious group (Leitzmann, 2014). These early documents described a type of vegetarian diet associated with those who were practicing Orphism, a mystic religion of ancient Greece. One religious-based practice in Orphism was to prohibit consumption of animals or animal-related products based on the philosophy of reincarnation. Reincarnation is the religious concept of rebirth, in which one goes through a continuous cycle of birth, life, and death. More specifically in rebirth, they believe that the soul is immortal. After death, the soul passes to another body, thereby, continuing in a repeated cycle. According to Leitzmann (2014), consumption of animals was considered harmful to their way of life and a way of contaminating their spirit, therefore Orphics perceived that a vegetarian diet would cleanse them of spiritual contamination.

During this same era, another historical group that disfavored meat consumption were the Pythagoreans (*World History of Vegetarianism*, 2019). Pythagoreans were adherents of Pythagoras, who was an ancient Greek philosopher considered to be "the father of ethical vegetarianism" (Leitzmann, 2014). Interestingly, they were vegetarians for spiritual-related

purposes and not health-related reasons, who felt that a plant-based diet led to a more peaceful life and coexistence. Primarily, their avoidance of meat consumption was based on the religious teachings of Pythagoras regarding reincarnation, much like that of the doctrines of Orphism. As to reincarnation, Pythagoreans also believed in transmigration in which souls could transfer after death, even between different species such as human to animal and vice versa. Due to their belief in transmigration, their vegetarian dietary pattern was at one time referred to as the “Pythagorean diet” (Leitzmann, 2014). Later in 1944, this term was changed to vegan. Pythagoreans also kept their vegetarianism a secret due to the fear of persecution from Western beliefs, such as those of the Romans (*World history of Vegetarianism: The Vegetarian Society*, 2019). The Romans believed the animal kingdom was designed for human-use and consumption. Pythagoras argued against their beliefs that God would take pride in the sacrifice of animals, instead he thought it to be negligence.

Centuries later, documentation of the vegetarian diet continued (Melina et al., 2016). During the 18th century, there were reports that the vegetarian diet was practiced by various religious communities and persons of influence (*World history of Vegetarianism: The Vegetarian Society*, 2019). For example, in 1817, an American chapter of the British-based Christian Bible Church (CBC) was established as the first American vegetarian church in Philadelphia, Pennsylvania (Avey, 2014). The church was founded to encourage abstinence from eating the flesh of animals. The CBC believed that man was saved by his value for life, thus promoting vegetarianism to protect God’s creations.

As for people of influence, many notable figures during this time began to practice the vegetarian diet (Avey, 2014). Some of the notable vegetarians included Benjamin Franklin, Susan B. Anthony, and Upton Sinclair (Avey, 2014). Many of which became vegetarians

secondary to the divulgence of unsanitary meat packing procedures reported in the book, “The Jungle,” by Upton Sinclair in 1906 (Sinclair, 1985).

Earlier historical aspects of the vegetarian diet in the US were also described in the book, “The Vegetarian Crusade: The Rise of an American Reform Movement, 1817-1921” which was written by Adam D. Shprintzen (2013). This book was a story about the American reform movement related to vegetarianism. The movement was political and ideological, inspiring the writing of how the vegetarian diet was associated with social, political, and personal aspects in the US at that time. This span of time was influenced by a consumption-driven economy in which consumer spending was priority (Shprintzen, 2013). The vegetarian diet was promoted to offer personal strength and success, changing how vegetarianism was accepted and expanded throughout society.

Many religions that practice in the US have adopted vegetarianism, such as the Seventh-day Adventists and Mormons (Banta et al., 2018; Jackson, 2016). Throughout America, Seventh-day Adventist churches have encouraged the vegetarian diet with around 30% of Seventh Day Adventists who followed the vegetarian diet in 2013 (*Seventh-day Adventists and health*, 2013). The leaders of this church conducted research by analyzing various scientific articles to determine if vegetarianism could lead to a longer and healthier life. Banta (2018) informed that in their communities, they often have vegetarian grocery stores and serve vegetarian meals at their schools. Another religion that commonly follows the vegetarian diet is the Mormon religion due to health benefits (Rouse et al., 1982). In the Mormon religion, moderation is strongly encouraged regarding the consumption of meat (McCaffree, n.d.). Seventh Day Adventists and Mormons follow the vegetarian diet based on their morals such as in the promotion of life.

Even though the vegetarian diet had been in existence for numerous years, the term ‘vegetarianism’ did not become a part of the American vocabulary until 1850 (Jackson, 2016). With notable figures and religions, such as Benjamin Franklin and the CBC, advocating the vegetarian diet, the term ‘vegetarian’ became recognized and better understood by society. The vegetarian diet has continued to evolve in the US and has been categorized into different types.

Types of Vegetarian Diets

The vegetarian diet is defined as the practice of not eating the flesh of animals, such as that of cows, poultry, freshwater fish, and seafood (Melina et al., 2016). However, within this diet, there are different types of dietary patterns or meal plans. As described by the Mayo Clinic (2020), the four main types of the vegetarian diet include pescatarian (fish may be consumed), ovo-vegetarian (eggs may be consumed), lacto-ovo-vegetarian (eggs and dairy may be consumed), and lacto-vegetarian (dairy may be consumed). As for prevalence of vegetarianism by types, a 2011 National Harris Interactive Poll disclosed that around 5% of Americans identified themselves as being vegetarians, with 2.5% considering themselves lacto-ovo-vegetarians (Reinhart, 2021).

In a study comparing the different types of the vegetarian diet, dietary quality was considered (Clarys et al., 2014). The quality of the diet was judged in relation to the Dietary Guidelines for Americans (*Dietary guidelines for Americans*, n.d.). The diet quality was measured using the Healthy Eating Index (HEI) 2010 through a food frequency questionnaire (FFQ) (Clarys et al., 2014). The FFQ in this study was an online survey consisting of 52 food items. The results were compared between vegetarians, semi-vegetarians such as ovo-vegetarians or lacto-ovo-vegetarians, pescatarians, and omnivores (*Vegetarian diet: How to get the best*

nutrition, 2020). The dietary quality scores were as follows: Vegans- 65.4, Vegetarians- 58.7, Semi-vegetarians- 59.4, Pescatarians- 58.7 and Omnivores- 54.2 (Clarys et al., 2014). These scores are out of 100 and the higher the number, the better the score and dietary quality. Comparisons between the different vegetarian diets found that the vegan diet had the highest dietary quality score due to low-sodium intake, high intake of fruits and vegetables, and low intake of saturated fat (Clarys et al., 2014). According to the MayoClinic, on average, one who participates in the vegetarian diet should consume 2.5 cups of vegetables, 2 cups of fruit and 6.5 ounces of whole grains a day. Overall, it was reported that the vegetarian diet consumed less energy than the omnivore diet and that those who followed the plant-based diets had higher levels of iron, poly-unsaturated fats, and dietary fiber. Omnivores were also found to take in lower amounts of calcium in their diets receiving the lowest HEI score causing the diet to be noted as a lower quality diet.

Vegetarian Diets and Adults in the United States

As for adults living in the US and the vegetarian diet, according to Cramer (2017), it was found that those who follow the vegetarian diet for health reasons were more likely aged 30-65 years, female, non-Hispanic, and from the western region of the US. It was also found that vegetarians were at least high school educated, chronically ill, and physically active. In addition, the participants were less likely to be smokers, in a relationship, or to be either overweight or obese. According to this study, 59.4% of these vegetarians disclosed their diet with their healthcare provider and 26.1% were vegetarian due to hypercholesterolemia.

Vegetarian Diet and Gender

Statistics from 2020 have shown that of the 5% of Americans who practiced vegetarianism, the majority were females at 86% (Rosenfeld, 2020; Torna et al., 2021). Studies have indicated that females appear more meticulous in following the vegetarian diet when compared to males (Rosenfeld, D. L., 2020; Torna et al., 2021). This could be because females are more socially motivated, meaning they have more of an intention to assist people. Since it appears that females follow the vegetarian diet more closely than males, it could possibly be due to a higher source of empathy; being empathetic, they may care more about the humane treatment of animals or the wellness of the environment. While on the other hand, females have also been interviewed as to why they adhere to an omnivorous diet (Barr, 2022). Barr (2002) described their reasons as being: not feeling as healthy as they used to, concern for nutritional status, changes in living situations, or even missing the taste of meat.

Vegetarian Diet and The Environment

Not only does it appear that the vegetarian diet may provide health benefits, but it may also benefit the environment when compared to a nonvegetarian diet (Soret et al., 2014). Some adverse effects of the nonvegetarian diet on the environment include that of climate change, such as from greenhouse gas emissions, increased food wastes, and more usage of land and water. Climate change refers to long term shifts in weather patterns and temperatures of the Earth and any associated adverse effects (Soret et al., 2014). However, there is a debate regarding whether the vegetarian diet can make a difference or that it also can have adverse environmental effects (Soret et al., 2014).

As noted by Soret et al. (2014), greenhouse gas emissions (GHGEs) are thought to be a major consequence of the nonvegetarian diet in the US. Greenhouse gases are described as gases in the Earth's atmosphere that trap heat and have the potential of increasing the temperature of the Earth's surface. An increase in the Earth's surface temperature can be detrimental due to the increase of severity of natural disasters such as hurricanes or earthquakes (*What is the greenhouse effect?*, n.d.). GHGEs include methane, a colorless, odorless gas that results from decomposing organic substances, such as from the gas released when cattle digest food (Haspel, 2014). Around 30% of the greenhouse gases appear to stem from meat consumption, whereas a vegetarian diet has been found to reduce greenhouse gas emissions by 22-29% (Fresán & Sabaté, 2019). There are approximately 91.9 million cattle in the US and it is estimated that every American consumes around 67 pounds of beef per year, increasing the creation and emission of GHGEs. (Davis & Lin, n.d.; *United States Department of Agriculture*, n.d.). Therefore, with a vegetarian diet, less GHGEs are released into the environment, which may indicate that the vegetarian diet is less taxing on the environment (Soret et al., 2014). However, this has not been proven.

Not only may GHGEs be reduced in association with the vegetarian diet, but also the amount of food waste (Fresán & Sabaté, 2019). Some of the ways that animal products can be wasted in the US includes spoilage and contamination. According to Fresán (2019), it was found that in areas of greater socioeconomic status, more than 30% of the food purchased was not consumed and instead discarded due to spoilage, which can lead to an increase in waste production (Fresán & Sabaté, 2019). This can fill not only landfills, but can affect the US water systems as well due to the pollution from waste products. With plant waste, compost can be benefitted.

Over the years, land, water, and energy use has increased due to the growth of the population (Boretti & Rosa, 2019). With the population expanding, the need for food production increased and therefore land and water use increased (*Chemistry journals, books, and ... n.d.*). Food production in the US can consist of agricultural crops, such as grains, vegetables and fruits as well as livestock, such as dairy cows, beef cattle, pig, poultry, sheep and seafood. Livestock farms compromise about 70% of agricultural land globally (Chai et al., 2019). Deforestation of the environment continues to increase due to the need for land for construction for civilization and agriculture (Chai et al., 2019). The nonvegetarian diet uses 13 times more fertilizer as the vegetarian diet to keep up with animals and manure. A nonvegetarian diet's water use is 2.9 times as much as the vegetarian diet due to the development of animal-based products. The omnivore diet uses 2.5 times as much primary energy, which is energy that is derived directly from natural resources. This plays a significant role in the release of CO₂ into our atmosphere due the burning of natural gas and oil with food production and the creation of fertilizer; water is involved as a lubricant. With the omnivore diet, the data regarding the increased use of water, primary energy and fertilizer is significant. By increasing practices of a vegetarian diet, these numbers could be reduced, which may have an effect on slowing down the consequences of climate change.

However, there is a debate whether changing to a vegetarian diet will greatly lessen the adverse environmental effects of the nonvegetarian diet (Fresán & Sabate, 2019). According to Fresán & Sabate, countries that are impoverished, would have higher emissions due to the need for consumption of animal products. This consumption would be needed to meet nutritional recommendations for dietary protein intake (2019). Therefore, the culture of the food systems would have to change before any sustainable effects would come from the consumption of the

vegetarian diet according to the article by Fresán and Sabate (2019). In addition, another study disclosed that those who have been vegetarian for a greater time may consume more ultra-processed foods (Tso & Ford, 2021). Ultra-processed foods are foods that are high in energy, fat, sugar, and salt that may cause adverse health effects such as increased risk of chronic illness and obesity. Regarding the environment, these types of food have an adverse impact due to factory waste, such as CO₂ emissions, packaging and non-sustainable efforts, such as using more land, water and energy. Tso and Ford (2021) also argue that it appears that vegetarian diets are not healthier or more sustainable.

In conclusion, GHGEs appear to play a role in climate change and associated effects (Soret et al., 2014). If the climate is no longer able to support food production, the effects on health could be detrimental. The vegetarian diet has the potential to decrease the rate of climate change by lowering GHGEs produced through reducing meat production (Soret et al., 2014).

Vegetarian Diet and Chronic Illnesses

Research has reported that the vegetarian diet may play a significant role in decreasing the risk of nutrition-related chronic illnesses (Sun, 2021; Garbett, 2016; Leitzmann, 2014). These chronic illnesses can include cancer, cardiovascular disease, hypertension, type II diabetes and those related to mental health. It has been found that these chronic illnesses are highly correlated with diet and what nutrients are consumed (Zhang, et al., 2015). With the vegetarian diet being a plant-based diet, it is high in nutrients including phytochemicals and antioxidants.

Phytochemicals, as well as antioxidants, such as vitamin C or vitamin E, have been shown to be beneficial in reducing risk of chronic illness, particularly cardiovascular disease and certain cancers (Tun et al., 2020; Zhang, et al., 2015).

Cancer

Cancer is a disease in which normal cells become abnormal and divide rapidly, possibly metastasizing and spreading to other areas of the human body (Sarkar et al., 2013). In 2022, cancer was the second leading cause of death in the US after heart disease (*FASTSTATS - leading causes of Death, 2022*). There are certain cancers that are associated with higher dietary intake of energy-dense and high-fat foods, however there are elements in the vegetarian diet that decrease the risk of certain cancers (Laino, C., 2011; *An update on cancer deaths in the United States, 2021; What type of foods cause colorectal cancer?*, n.d.). These types of cancer include colorectal cancer (Laino, C., 2011; *An update on cancer deaths in the United States, 2021*). With colorectal cancer, foods that may increase the risk of developing the disease include red and processed meats as well as white bread; however, with the vegetarian diet, colorectal cancer may be reduced due to a reduced intake of red and processed meats and an increased intake of fiber (*What type of foods cause colorectal cancer?*, n.d.; Laino, C., 2011). Foods in the vegetarian diet that have been associated with a lower risk of developing this cancer include fruits, vegetables and whole grains (Team, 2021). Yet, if there are not sufficient amounts of Vitamin D obtained mostly from animal products in the diet, cancer may progress at a faster rate (Laino, C., 2011; *An update on cancer deaths in the United States, 2021*). Some ways vegetarians can consume vitamin D is through mushrooms and fortified cereals and by getting some sunshine.

Cardiovascular Disease

Cardiovascular disease (CVD) was the leading cause of death in the US in 2022 and is estimated to affect 85.6 million Americans (*FASTSTATS - leading causes of Death, 2022; Kahleova et al., 2018*). CVD includes conditions such as coronary heart disease, stroke, peripheral arterial disease and aortic disease. Foods in the nonvegetarian diet that may increase

risk of CVD include processed meats and saturated fat, whereas, food in the vegetarian diet that may help reduce CVD risk include fruits and vegetables such as fiber and antioxidants. Fiber is thought to lower the risk of CVD by improving blood lipids profiles. In addition, the vegetarian diet may lead to lower rates of heart disease secondary to the decreased amounts of saturated fats and higher fiber intake. In fact, the vegetarian diet has been shown to decrease the risk of a myocardial infarction and coronary heart disease by 40% (Kahleova, H., et al., 2018).

Hypertension

Hypertension is another nutrition-related chronic illness of concern (Alexander, S., 2017). It is diagnosed when the systolic blood pressure reads higher than 140 mm Hg and the diastolic blood pressure reads higher than 90 mm Hg (*High blood pressure symptoms and Causes*, 2021). Of interest, in 2021, nearly half of all adults in the US were diagnosed with hypertension which can lead to long-term effects of stroke, myocardial infarctions, renal failure, limb loss, aortic aneurysm and atrial fibrillation (Alexander, S., 2017; Singh et al., 2017). Vegetarians have been shown to have a lesser risk of developing hypertension secondary to having higher amounts of plant-based proteins and glutamic acids (Garbett et al, 2016; Lee et al., 2020). Examples of foods high in glutamic acids are eggs, fish and dairy products. Glutamine works to lower blood pressure through its involvement in vasodilation (the expanding on blood vessels) (Jinna, et al., 2019). Foods with plant-based protein and glutamic acids appear to reduce blood pressure secondary to a higher content of potassium (Rheinschild, 2017). Potassium helps relax the walls of blood vessels, decreasing the risk of hypertension (*Potassium lowers blood pressure*, 2017).

Type II Diabetes

Type II diabetes, a chronic illness prominent in the US, occurs when the body fails to respond to or produce insulin as it should (Snowdon et al., 1985). In 2022, diabetes was the

eighth leading cause of death in the US (*FASTSTATS - leading causes of Death*, 2022). Tonstad (2009) found that nonvegetarians across North America were 7.6% more likely to suffer from type II diabetes compared to vegetarians. Another study by Snowdon et al. (year), reported that correlations between meat consumption and type II diabetes appear to be stronger in males than females. This same study showed that vegetarians were less likely to die from diabetes than those who were nonvegetarians. According to the article by Soret in 2014 with human research (HR), mortality rates due to type II diabetes were significantly lower for those who followed semi-vegetarian (0.86) or vegetarian diets (0.91) on a one-point scale.

Mental Health

Mental health is an important aspect of health that does not regard physical health; it is defined as a person's condition with regard to their psychological and emotional well-being (Michalak et al., 2012). Some mental illnesses that may be related to nutrition include depression and anxiety (*Nutrition and mental health: What's the link?*, n.d.). In relation to mental health, it was found that South Asians living in the US who follow the vegetarian diet were 43% less likely to suffer from depression (Jin et al., 2021). However, according to another study, vegetarians actually reported a higher prevalence of anxiety and depressive disorders (Michalak et al., 2012). This may be due to the fact that many individuals with eating disorders follow vegetarian/ vegan diets and have co-existing anxiety and depression. This suggests that the vegetarian diet is associated with both positive and negative consequences for physical and mental health (Michalak et al., 2012; Jin et al., 2021). Further research is needed to investigate the role of the vegetarian diet and mental health.

Vegetarian Diet and Body Composition in the United States

According to Craig (2010) and Berkow (2005), there appears to be a negative relationship between the vegetarian diet and adult body composition. Body composition can be defined as the physical make-up of the body impacted by gender, age, race, nutrition, physical activity, and hormonal status (Gallagher et al., 2013). Factors of body composition include the percentages of body fat, lean muscle mass, bone mass, and water in the human body. Methods that may be used to measure body composition include anthropometric measurements such as waist circumference, weight, height, and skinfold measurements. In addition, x-rays, such as a Dual-energy X-ray absorptiometry (DEXA) scan, can be used. This scan can measure bone density as well as body fat percentage and lean muscle mass.

The main component of body composition that appears to be impacted by a lower fat vegetarian diet is body fat percentage (Villines, 2020). The data regarding the average body fat percentages in vegetarians noted that the lowest was in vegans (Najjar & Feresin, 2019). Body fat percentage is defined as the percentage of the body that consists of fat, in which it is recommended that men have a range from 2-24% and women from 10-31% to be classified as healthy (*Learn about the body fat percentage - health insights*, n.d.). In comparison to the non-vegetarian diet, the vegetarian diet is generally lower in saturated fats and cholesterol while higher in fiber and phytochemicals, which can affect body composition and body fat percentage (Craig, 2010).

Following a vegetarian diet may improve body fat percentages due to the reduction of dietary saturated fats and increased amounts of unsaturated fats (Kahleova, 2019). Saturated fats are fatty acids without double bonds. There are different types of unsaturated fats, such as monounsaturated fats that have only one double bond and polyunsaturated fats that have several.

In a study by Kahleova (2019) based on a low-fat vegan diet, it was shown that a decrease intake of saturated fats may lead to lower fat mass in participants (Kahleova, 2019). In regard to unsaturated fats, the study found that linoleic and α -linolenic acids appear to be associated with decreased fat mass. Linoleic acids are omega-6 fatty acids while α -linolenic are omega-3 fatty acids. This effect could be due to the essential fatty acids building cell structure functioning as the body's main storage reserve. Both omega-3 and omega-6 fatty acids are important fats needed for human growth and development. Having reduced saturated fats may affect body composition by reducing BMI and waist circumference. Also, because of the anti-inflammatory properties in unsaturated fats, chronic illness such as hypertension and CVD as well as obesity, can be benefitted.

In addition, there is an increased consumption of fruits, vegetables, and whole grains in the vegetarian diet, which may also be a factor in lowering body fat percentages (Craig, 2010; Pohl et al., 2021). Those on vegetarian diets also tend to eat fewer calories. Fiber and phytochemicals from fruits, vegetables, and whole grains may influence body fat by improving insulin sensitivity, glucose metabolism and by slowing the absorption of food (*Whole grains*, 2019).

Research regarding the effects of the vegetarian diet and lean muscle mass have shown significance (Boutros et al., 2020; Turner-McGrievy, et al., 2017). By definition, lean muscle mass is the total weight of your body minus all the weight due to fat and bone mass (*What is the difference between lean body mass and muscle mass?*, 2021). When assessing lean muscle mass, the body should be within 70-90% to be classified as healthy for both males and females (*Lean body mass explained*, 2020). Research has argued that vegans have a lower lean muscle mass, yet still fall within a normal range when compared to vegetarians and omnivores (Boutros et al.,

2020; Turner-McGrievy, et al., 2017). This may be due to macronutrient intake of carbohydrates, fats, and proteins. This affects lean muscle mass, because to build muscles, all of these macronutrients are needed in sufficient amounts.

In a study by Boutros, it was found that a vegetarian diet is not detrimental to lean muscle health and may even be beneficial considering vegetarians had the highest VO2 max when compared with omnivores (Boutros et al., 2020). This could relate to having a healthier lean muscle percentage. VO2 max is the maximum rate of oxygen consumption measured during incremental exercise of increasing intensity. VO2 max is an indicator of cardiovascular health and may be related to muscle health by showing the endurance levels the muscles are able to carry out. This could affect muscle mass by having a better performance rate and therefore better lean muscle synthesis. In a study by Gilbert (2011), it was stated that more research is needed on whether or not animal-based or plant-based proteins play a greater role in muscle synthesis (Gilbert, 2011).

It has been argued that a balanced vegetarian diet provides the essential nutrients required for a healthy foundation of building and maintaining strong bones due to levels of calcium vitamin D, and vitamin K providing the skeleton with strength and structure (Chuang et al., 2020). Bone mass is defined as measure of the amount of minerals (mostly calcium and phosphorous) contained in a set volume of bone (*NCI Dictionary of Cancer terms*, n.d.). Bone mass is determined by a central DEXA scan. A DEXA scan is used to measure bone mineral density, which is the amount of minerals within the bones. A central DEXA scan is a procedure that measures the amount of calcium and other minerals in a bone by passing x-rays with two different energy levels through the bone (*NCI Dictionary of Cancer terms*, n.d.). While assessing bone mass, a healthy t-score is one in the range of -1 to +1 (*Bone mass measurement: What the*

numbers mean, n.d.). Results for vegetarian bone health was conflicting and came down to comparing to overall dietary quality (Chuang et al., 2020). Yet, others argue that following a vegetarian diet long-term can decrease bone health due to the lack of vitamin D (Fontana, et al., 2005). The vegetarian diet may lack vitamin D due to the main source of the vitamin being from animal products. In a study by Chuang (2020), it was contended that more research is indicated since the comparison of the vegetarian diet and bone health is very complex. A diet too high in protein is actually detrimental and fruits and veggies can protect bone, all via acidity.

Since many fruits and vegetables have higher water content, the vegetarian diet promotes consumption of more water in addition to normal fluid intake, which can affect the levels of body water composition (*Hydration for vegans: What you need to know on a vegan diet*, 2021). Body water percentage is defined as the amount of water in your body, expressed as a percentage of total weight (*Body water: Percentage and ratios you should know.*, 2020). Regarding body water percentage, it is recommended that men have between 50 and 65% while women should have 45-60% (*Understanding body water percentage - health insights*, n.d.). Body water percentage can be affected by exercise, diet, and climate. It is important to drink water with a vegetarian diet because water helps fiber move along the digestive path. According to a study in 2021, it was found that a general guideline for fluid requirements should equal calorie intake for vegetarians. For example, if someone were to consume 2000 kcal per day, they would need 2000 mL (or 2 L) of water per day (*Hydration for vegans: What you need to know on a vegan diet*, 2021).

Vegetarian Diet and Obesity in the United States

The effects of the vegetarian diet may lead to positive effects on obesity in adults in the United States, as evidenced by a lower body mass index (BMI) and lower body fat percentages (Huang et al., 2016). BMI, also referred to as the Quetelet's index, is calculated by weight in kilograms divided by height in meters squared (Garabed, 2008). BMI assesses healthy weight levels and is divided into three categories: normal weight, overweight and obesity. A normal weight BMI would fall between 18.4-24.9. An overweight BMI would range from 25.0-29.9, while obese would be equal to or greater than 30. The concern regarding obesity is that it is associated with many chronic illnesses, such as cardiovascular disease, type II diabetes, and hypertension (Clark, J. M., & Brancati, F. L., 2000).

There has been research that argues that the vegetarian diet may reduce the risk of obesity (Tonstad, 2009). A study by Tonstad (2009) reported the following averages of BMI per type of diet: 23.6 kg/m² in vegans, in 25.7 kg/m² lacto-ovo vegetarians, pescatarians 26.3 kg/m² in pescatarians, 27.3 kg/m² semi-vegetarians, and 28.8 kg/m² in nonvegetarians. This study consisted of both adult male and female participants who were members of the Seventh-Day Adventists Church. It also concluded that vegetarians appear to have a healthier BMI than those who are nonvegetarians due to the consumption of macronutrients such as carbohydrates, proteins and fats. Since everyone consumes these, it may fall down to how these macronutrients are prepared; think fried versus steamed.

In a study investigating diet in relation to obesity by Newby (2005), it was found that vegetarian women were less likely to be categorized as obese when compared to omnivorous women (Newby et al., 2005). Newby proposed that eating more plants rather than animal products may help control weight due being less energy dense. In addition, according to the Academy of Nutrition and Dietetics (AND) position paper on the vegetarian diet, those who

avoided meat products had the lowest BMI with a BMI of 23.6 when compared to omnivores at 28.8 (Melina et al., 2016). Further, the vegetarian diet has a good long term health outcome regarding obesity and may even be better than those who are omnivores (Appleby & Key, 2016). Also, in a study by Hitti (2006), it was stated that around 6% of vegetarians were considered obese, leaving 94% of vegetarians in better BMI categories. The lower BMI was thought to be related to the increased consumption of whole grains, fruit and vegetables and with the reduction of saturated fat intake.

Vegetarian diets have been reported to have significant effects on weight loss compared to nonvegetarian diets (Huang et al., 2016). According to a study by Tran, the weight reduction found in both males and females following a plant-based diet was due to an increased intake of fiber, polyunsaturated fats, and plant proteins, secondary to reducing intake of energy, saturated fats, and animal proteins (Tran et al., 2020). Based on its relationship to a healthier BMI, it appears that the vegetarian diet may have an impact regarding lowering the risk of chronic illnesses, such as cardiovascular disease, hypertension, and type II diabetes. It has been shown that even just a 5% weight loss of body weight, following any diet, decreases the risk of developing chronic diseases (Turner-McGrievy, et al., 2017). This could be due to the combined effects of weight loss and increased consumption of fiber.

Yet, there are vegetarians who fall into the obese category (Hitti, 2006). In 2006, a study by Hitti found that around 6% of vegetarians were considered obese, compared to 4-45% of nonvegetarians were considered obese (Hitti, 2006). It is thought that some vegetarians may fall in the obese category due to increased consumption of refined carbohydrates and processed foods such as cereals, pastas, and white bread. Basically, obesity can occur secondary to excessive caloric intake, whether following a vegetarian or nonvegetarian diet. For both diet

patterns, caloric intake in adults is recommended to be around 2,000-3,200kcal/day depending on activity level (McLaughlin, 2018).

Risks of the Vegetarian Diet

With the vegetarian diet, there can be concern for nutrient deficiencies (Craig, 2010). According to Craig (2010), these nutrients include vitamin B12, vitamin D, omega-3 fatty acids, calcium, iron, and zinc. With vitamin B12, it is not synthesized in the body so it must come from the diet. Since vitamin B12 mostly comes from animal products, vegetarians can face increased risk of its deficiency (Shurtleff, 1983). Omega-3 fatty acids are required for one to be in good health, which creates concern for the risk of deficiency. With possible reduced intake of omega-3 fatty acids in the vegetarian diet, these participants can get their sources from consuming seaweed and seeds such as chia or hemp (*15 omega-3-rich foods: Fish and vegetarian sources*, (n.d.)). Considering that most vitamin D sources come from animal products, there is an indication that many vegetarians may struggle to attain sufficient amounts of vitamin D in their diet. Another risk found was that those who follow a raw-food vegetarian diet are more likely to have a lower bone mass (Fontana, et al., 2005). This could be from the lack of calcium when not eating animal products such as dairy. As stated by Howie (1985), not only does the vegetarian diet affect nutrient levels, but also hormonal levels. The study by Howie (1985) showed that there was a possible risk for decreased levels of plasma concentrations involving androgen and estrogen in vegetarians. Further risks include athletes or those who are physically active and following a vegetarian diet. There is a chance that with the increased intake of protein as a way to increase glycogen stores, there could be a reduction of the bioavailability of several nutrients (Nieman, 1999). According to Nieman (1999), these nutrients include zinc, iron and some other

trace minerals. With these risks, there are certain populations who may be advised to not follow a vegetarian diet. These population include those with anemia, kidney disease or certain food allergies (McFarland, 2022).

Conclusion

In general, the vegetarian diet is popular due to sustainability, the ethical treatment of animals, cultural identities, religious beliefs, and health reasons including weight loss, a lower risk of developing chronic illnesses (Torna et al., 2021, Huang et al., 2016, *Vegetarianism and meat-eating in 8 religions*, 2021). Specifically, the article by Torna (2021) showed that those who follow the vegetarian diet for health reasons had a healthier eating index (HEI) than those who participated for other reasons (Torna et al., 2021). Following the vegetarian diet has many proven benefits, including a lower morbidity and mortality rate than omnivores (Messina, et al., 1997). The vegetarian diet is higher in antioxidants when compared to the omnivorous diet (Rauma, 2000). With antioxidants, the risk of chronic illnesses, such as heart disease, are reduced. These antioxidants also help with obesity since they have anti-inflammatory properties and obesity is an inflammatory condition (Tun et al., 2020). All of these are significant factors in body composition and a human's life.

Yet, the vegetarian diet is not just another fad weight-loss diet (Smith, 2000). The study by Smith (2000) showed that when compared to other weight-loss diets, the vegetarian diet was more effective due to the longevity of participation. Smith (2000) described that it was shown that 62% of vegetarians followed the vegetarian diet for a year or more, while 61% of those following other weight-loss diets quit within 3 months. Arguing that the vegetarian diet is a

sustainable diet for humans. By participating in the vegetarian diet, American adults could combat this obesity epidemic and develop a healthful body composition.

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