

A top-down view of several walnuts scattered on a white surface. A small, light-colored ceramic bowl is filled with walnuts in the lower-left quadrant. The walnuts are golden-brown and have a characteristic wrinkled texture.

CALIFORNIA WALNUTS NUTRITION & SCIENTIFIC RESEARCH

**A RESOURCE GUIDE
FOR HEALTH
PROFESSIONALS**







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Health Research on Walnuts

For more than 25 years, the California Walnut Commission has supported scientific research on consumption of walnuts and outcomes in the following areas:

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WHY WALNUTS?

WALNUTS ARE THE ONLY NUT to contain a significant amount of the plant-based omega-3 alpha-Linolenic acid (2.5 grams/ounce). One ounce of walnuts also offers four grams of protein, two grams of fibre, and is a good source of magnesium (10% DV).

Walnuts' unique nutrient profile also makes meeting the Eatwell Guide easy and delicious. The guidelines encourage UK consumers to have healthy, balanced diets by eating 5 portions of fruit and vegetables a day, base meals on starchy foods, consume some dairy, choose unsaturated oils and spreads, drink plenty of fluids and finally, consume some protein-rich foods which includes meat, eggs, pulses and nuts.¹

There is also an emphasis on reducing saturated fat intake to less than 10 percent of calories per day and shifting food choices from those that contain saturated fats to those with polyunsaturated fats. Walnuts are predominantly composed of polyunsaturated fat (13 out of 18 grams of total fat per 1 ounce serving).

A STUDY FROM THE HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH suggests people who replace saturated fats with polyunsaturated fats in their diet may have a lower risk of heart disease.² The study analysed the diets of nearly 85,000 nurses and 43,000 doctors every four years over 30 years. After calculating the percentage of calories the participants received from polyunsaturated fatty acids (PUFAs), monounsaturated fatty acids (MUFAs), whole grain carbohydrates and refined carbohydrates, the study found that substituting five percent of the calories from saturated fat with the same amount of energy from PUFAs was associated with a 25 percent lower risk of coronary heart disease (CHD). Replacing saturated fats with equivalent energy intake from MUFAs or whole grain carbohydrates was associated with a 15 percent and nine percent lower risk of CHD, respectively. Given this was an observational study, the findings cannot prove causality and additional research is needed to determine how these results apply to more diverse populations. Furthermore, residual confounding cannot be ruled out.

AS A NUTRIENT-DENSE FOOD, walnuts can be eaten in place of less healthy choices to improve overall diet quality. A study from Yale University's Yale-Griffin Prevention Research Center found that including walnuts in a habitual diet, with or without reduced calorie intake, significantly improved diet quality in adult men and women at high risk for diabetes.³ Diet quality was assessed using the Healthy Eating Index 2010 (HEI-2010). In this parallel design study, participants (31 men and 81 women ages 25-75) were assigned to a calorie adjusted diet or an *ad libitum* diet and were also randomised to two different sequences to include or exclude walnuts. Participants were provided 392 grams of walnuts per week (2 ounces per day) to include in their diet and received guidance from a dietitian while on the calorie adjusted diet. Larger studies in more diverse populations are needed to clarify the results.

¹www.nhs.uk/live-well/eat-well/the-eatwell-guide

²Li Y, Hruby A, Bernstein AM, et al. Saturated fats compared with unsaturated fats and sources of carbohydrates in relation to risk of coronary heart disease. *J Am Coll Cardiol*. 2015;66(14):1538-48.

³Njike VY, Ayettey R, Petraro P, et al. Walnut ingestion in adults at risk for diabetes: effects on body composition, diet quality, and cardiac risk measures. *BMJ Open Diabetes Res Care*. 2015;3(1):e000115.





A DAILY SERVING

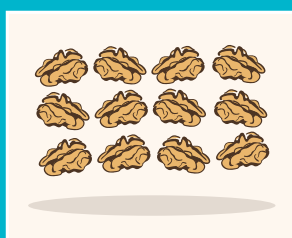
OF WALNUTS IS:



38g



1/4 CUP



12-14 HALVES



1 HANDFUL

NUTRITION FACTS FOR WALNUTS

Nutrition Facts

Serving Size 1oz. (28g / about 1/4 cup)

Amount Per Serving
Calories 190

% Daily Value*

Total Fat 18g 23%

Saturated Fat 1.5g 8%

Trans Fat 0g

Polyunsaturated Fat 13g

Monounsaturated Fat 2.5g

Cholesterol 0mg 0%

Sodium 0mg 0%

Total Carbohydrate 4g 1%

Dietary Fibre 2g 7%

Total Sugars 1g

Incl. 0g Added Sugars 0%

Protein 4g

Vitamin D 0mcg 0%

Calcium 30mg 2%

Iron 0.8mg 4%

Potassium 130mg 2%

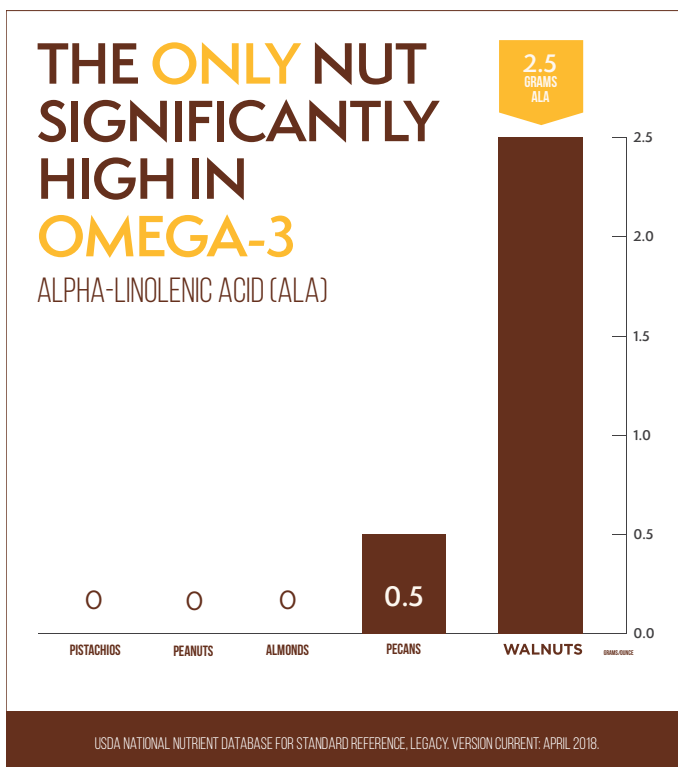
*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

ESSENTIAL OMEGA-3s

WALNUTS ARE UNIQUE AMONG NUTS

for they are primarily comprised of poly-unsaturated fatty acids, or PUFAs, with 13 out of 18 grams of total fat per one ounce serving. Many other nuts contain mostly monounsaturated fatty acids (MUFAs). As a result, walnuts are the only nut that offer an excellent source of the plant-based omega-3 alpha-Linolenic acid or ALA (2.5 grams per 1 ounce serving). Research specific to ALA and its contribution to health benefits continues to evolve.

Based on findings from a literature review, ALA may be as effective in reducing the risk of cardiovascular disease (CVD) as marine-derived omega-3s, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been shown to be.¹ This review presented evidence for a beneficial role of ALA in the primary and secondary prevention of CVD.



OMEGA-3 OVERVIEW

The predominant essential fatty acids in the human diet are alpha-Linolenic acid (ALA, an omega-3 fatty acid) and linoleic acid (LA, an omega-6 fatty acid). ALA is the precursor or “parent” to two important long-chain omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).²

In recent years, the number of studies describing the health-promoting benefits of omega-3 fatty acids has increased substantially, primarily in the area of heart health.¹

The role of ALA in the body relates to structural membrane lipids and a lack of ALA can result in a deficiency. The Dietary Reference Intake report that includes fatty acids set an adequate intake (AI) for ALA at 1.6 and 1.1 grams per day for men and women, respectively. While deficiency is rare, meeting the AI for ALA can provide the beneficial health effects associated with consumption of omega-3 fatty acids.²

ALPHA-LINOLENIC ACID – ALA (C18:3)

(Found in walnuts, flaxseed, soybean oil, canola oil)

OMEGA-3 FAMILY

EICOSAPENTAENOIC ACID – EPA (C20:5)

(Found in fatty fish including salmon, mackerel, trout)

DOCOSAHEXAENOIC ACID – DHA (C22:6)

(Found in fatty fish including salmon, mackerel, trout)

RESEARCH FROM THE LANDMARK PRE-
vención con Dieta MEDiterránea (PREDIMED)
study, one of the largest clinical trials, found
that both plant and marine-based sources of
omega-3s have complementary effects against
mortality in a population with high seafood
consumption.³ This secondary analysis looked
at data from participants in the PREDIMED
study. A total of 7,447 Spanish subjects (ages
55-80) at high risk of cardiovascular disease,
but with no symptoms at baseline, were
enrolled in the PREDIMED study and followed
for an average of 4.8 years. Subjects were
randomly assigned to a Mediterranean diet
supplemented with mixed nuts (15g walnuts,
or about 0.5 ounces, 7.5g almonds and 7.5g
hazelnuts per day), a Mediterranean diet
supplemented with extra virgin olive oil (at

least 50g or 4 tablespoons per day) or a low-
fat diet (control group). The study found that
consuming omega-3s from plant-based sources,
such as walnuts, may reduce risk of all-cause
mortality, whereas marine-derived omega-3s,
from fatty fish, may reduce the risk of heart-re-
lated fatalities. The greatest protective effects
from total mortality were observed in diets that
included both plant-based and marine-derived
omega-3s, as they appear to act synergistically.

***Though the findings cannot prove causality,
the research demonstrates that ALA may
provide additional health benefits even in
a population with high consumption of
EPA and DHA from seafood.***

RESEARCH IN HEALTHY ADULTS (ages
18-35) exhibited that regularly eating foods
that contain PUFAs, including walnuts,
salmon, tuna, flaxseed oil, grapeseed oil,
canola oil and fish oil supplements, may
significantly improve fat metabolism and
protect against the negative effects of
saturated fats such as high cholesterol
levels.⁴ For the study, researchers placed
26 healthy adults (13 men and 13 women)
on a diet rich in polyunsaturated fats (21%
polyunsaturated fat, 9% monounsaturated
fat, and 5% saturated fat) or a control diet
that was a typical American pattern (7% of
polyunsaturated fat, 15% monounsaturated
fat and 13% saturated fat) for seven days
and had them consume a meal high in
saturated fat (7% of polyunsaturated fat,
16% monounsaturated fat and 47%
saturated fat) before and after the seven
day diet. The diet rich in PUFAs was
achieved by participants' consuming
the whole foods described above in
conjunction with fish oil supplements.
Researchers observed significant decreases
in total cholesterol (TC) and low-density
lipoprotein (LDL) levels in the study
participants who followed an eating plan
rich in PUFAs, even though they were
young, healthy and didn't have high
cholesterol levels when the study began.

Residual confounding cannot be ruled out in
observational studies (i.e., other lifestyle habits
which are more common in adults who eat
foods containing omega-3s could contribute
to the study results).³ Larger and longer-term
studies, as well as studies in diverse populations,
are needed to clarify population-wide effects.^{3,4}
Additionally, more clinical trials are needed to
evaluate the effects of ALA intake on
cardiovascular disease risk as well as determine
the optimal quantity of all dietary omega-3
PUFAs to offer the greatest health benefit.^{1,3,4}
In the context of whole food diet, it is difficult
to discern whether changes seen with the
Mediterranean or PUFA-rich diet can be
attributed to one specific type of PUFA,
food source, or a combination of overall
dietary factors.^{3,4}

¹Fleming JA, Kris-Etherton PM. The evidence for α -linolenic acid and cardiovascular disease benefits: comparisons with eicosapentaenoic acid and docosahexaenoic acid. *Adv Nutr.* 2014;5(6):863S-76S. ²Dietary reference intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, protein, and amino acids (Macronutrients) (2005) NAS. IOM. Food and Nutrition Board. ³Sala-Vila A, Guasch-Ferré M, Hu FB, et al. Dietary α -linolenic acid, marine ω -3 fatty acids, and mortality in a population with high fish consumption: findings from the PREvención con Dieta MEDiterránea (PREDIMED) study. *J Am Heart Assoc.* 2016;5(1):e002543. ⁴Stevenson JL, Miller MK, Skillman HE, et al. A PUFA rich diet improves fat oxidation following saturated fat rich meal. *Eur J Nutr.* 2017;56(5):1845-1857.

WALNUTS & HEART HEALTH

SINCE 1993, published research has been investigating how eating walnuts affects various heart health biomarkers and risk markers including:

- LDL and HDL cholesterol
- Apolipoprotein B and non-HDL cholesterol
- Blood pressure
- Inflammation
- Endothelial function
- Plaque formation



**CALIFORNIA WALNUTS HAVE
THE HEART-HEALTHY SEAL OF
APPROVAL FROM HEART UK**

Heart UK Charity Reg No: 1003904



**WALNUTS ARE CERTIFIED BY THE
AMERICAN HEART ASSOCIATION
WITH THE HEART-CHECK MARK**

PER 1 OZ. SERVING

Please note that the Heart-Check Food Certification does not apply to scientific research by an organisation other than the AHA unless expressly stated. For more information, see the AHA nutrition guidelines at: heartcheckmark.org/guidelines.

Butternut Squash, Quinoa, Pear and Walnut Bowl





RESEARCH FROM THE LANDMARK

PREvención con Dieta MEDiterránea (PREDIMED) study further demonstrated the potential heart health benefits of walnuts. The study was conducted among more than 7,000 Spanish individuals (ages 55-80) at high risk for cardiovascular disease and found that a Mediterranean diet supplemented with mixed tree nuts (primarily walnuts), was associated with a lower risk of cardiovascular events, including cardiovascular death, myocardial infarction (heart attack), and stroke, when compared to a low-fat control diet.³

Larger and longer-term studies, as well as studies in more diverse populations, are needed to clarify population-wide effects.^{1,2,3} In some cases, the amount of walnuts consumed in these trials was relatively large and might be difficult to maintain in a non-research setting.^{1,2} A meta-analysis offers a comprehensive look at findings among patients of various backgrounds, however, it can be limited by the methods, reported outcomes and quality of the individual studies involved.² In the PREDIMED study, it is difficult to precisely define what part of the Mediterranean diet was associated with cardiovascular benefits.³

THE RESEARCH SUPPORTING the role that walnuts can play in heart health began with a Loma Linda University study, showing walnuts may lower total and LDL cholesterol in men by as much as 12 percent and 16 percent, respectively.¹ In this eight-week randomised, crossover trial, 18 healthy men (ages 21-43) were assigned to a cholesterol-lowering diet that did not include nuts or a cholesterol-lowering diet that included walnuts. All food was provided by the researchers and the walnut diet contained three servings (equivalent to 3 ounces) of walnuts per day.



A SYSTEMATIC REVIEW FROM THE HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

examined 25 years of evidence for the role of walnut consumption on cardiovascular risk factors, including cholesterol, triglycerides, blood pressure, and weight.² A meta-analysis was done on 26 randomised controlled trials representing 1059 individuals (ages 22-75), including those with a variety of conditions such as high cholesterol, type 2 diabetes, metabolic syndrome, overweight or obesity, as well as those that were healthy. When compared to control diets, including low-fat, Mediterranean, American or Japanese, a diet supplemented with walnuts in amounts varying from 5-24 percent of total calories per day (equivalent to 0.5-3.9 ounces per day) resulted in a significantly greater percent decrease in total cholesterol (3.25%), LDL cholesterol (3.73%), triglycerides (5.52%), and apolipoprotein B (4.19%). In addition, incorporating walnuts into the diet had no adverse effects on body weight or blood pressure, according to the studies included in the meta-analysis.

Due to the evidence supporting the cardiovascular benefits of walnuts, the U.S. Food and Drug Administration approved one of the first qualified health claims for a whole food in March of 2004: “Supportive but not conclusive research shows that eating 1.5 ounces of walnuts per day, as part of a low saturated fat and low cholesterol diet, and not resulting in increased caloric intake may reduce the risk of coronary heart disease.”⁴

¹Sabaté J, Fraser GE, Burke K, et al. Effects of walnuts on serum lipid levels and blood pressure in normal men. *N Engl J Med*. 1993;328:603-607.

²Guasch-Ferré M, Li J, Hu FB, et al. Effects of walnut consumption on blood lipids and other cardiovascular risk factors: an updated meta-analysis and systematic review of controlled trials. *Am J Clin Nutr*. 2018;108(1):174-187. doi: 10.1093/ajcn/nqy091.

³Estruch R, Ros E, Salas-Salvadó J, et al. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet Supplemented with Extra-Virgin Olive Oil or Nuts. *N Engl J Med*. 2018;378(25):e34. doi: 10.1056/NEJMoa1800389. ⁴One ounce of walnuts provides 18g of total fat, 2.5g of monounsaturated fat, 13g of polyunsaturated fat, including 2.5g of alpha-linolenic acid, the plant-based omega-3.

WALNUTS & HEALTHY AGING

SYNERGISTIC EFFECTS OF WALNUTS or their bioactive components may be contributing factors in protecting against the detrimental effects of aging. Research shows that nutrients found in walnuts, such as polyphenols, tocopherols and polyunsaturated fatty acids, may reduce oxidative stress and inflammation as well as help maintain neural membrane integrity and reduce protein aggregation involved in Alzheimer's disease.¹ Though more research is needed to confirm the benefits in humans, a review of animal studies suggests that the addition of walnuts (equivalent to a single serving or 1 ounce of walnuts for humans) is associated

with improved motor and cognitive behavior in aged animals. Additionally, human studies have shown that the inclusion of walnuts in the diet may improve cardiovascular health, which is a risk factor for neurodegenerative diseases and age-related cognitive decline.

Together, the evidence suggests that including walnuts as part of a healthy diet may play a role in helping to maintain and improve physical and cognitive health as people age.

COGNITIVE HEALTH

A STUDY PUBLISHED in the *Journal of the American Medical Association Internal Medicine* found that eating a Mediterranean diet supplemented with olive oil or nuts (primarily walnuts) was correlated with reduced age-related decline in cognitive function in an older Spanish population (ages 55-80) at high cardiovascular risk.² This clinical trial was conducted in a subcohort of the PREvención con Dieta MEDiterránea (PREDIMED) trial. Participants were randomly assigned to a Mediterranean diet supplemented with mixed nuts (15g walnuts, or about 0.5 ounces, 7.5g almonds and 7.5g hazelnuts per day), a Mediterranean diet supplemented with extra virgin olive oil (at least 50g or 4 tablespoons per day) or a low-fat diet (control group). The study found that participants who consumed a Mediterranean diet with nuts, including walnuts, showed improvements in memory compared to a low-fat diet.



ACCORDING TO A STUDY published in *The Journal of Nutrition, Health & Aging*, eating walnuts may improve performance on cognitive function tests, including those for memory, concentration and information processing speed in adults (ages 20-59 and 60 and older).³ In this retrospective study, cognitive function was consistently greater in adult participants who consumed walnuts, even after adjusting for age, gender, race, education, BMI, smoking, alcohol

consumption and physical activity. Analyses are based on single, 24-hour recalls, which reflect one day of intake for the subjects. This cross-sectional study was the first large representative analysis of walnut intake and cognitive function, and the only study to include all available cognitive data across multiple National Health and Nutrition Examination (NHANES) surveys, representing over 10,000 individuals.



AN ANIMAL STUDY PUBLISHED in the *Journal of Alzheimer's Disease* demonstrated that a diet including walnuts may have a beneficial effect in reducing the risk, delaying the onset, or slowing the progression of Alzheimer's disease.⁴ The research group examined the effects of dietary supplementation with six percent or nine percent walnuts in mice (equivalent to 1 ounce and 1.5 ounces of walnuts per day in humans) compared to a control diet with no walnuts. The study found significant improvement in learning skills, memory, anxiety reduction, and motor development in mice fed a walnut-enriched diet. This research stemmed from a previous cell culture study that highlighted the protective effects of walnut extract against the oxidative damage caused by amyloid beta protein, the major component of amyloid plaques that form in the brains of those with Alzheimer's disease.⁵ Findings from animal and cell studies are provided as background and used to formulate hypotheses for additional research needed to determine the effects on humans.

PHYSICAL FUNCTION

FINDINGS PUBLISHED in the *Journal of Nutrition* suggest that consumption of one to two servings of walnuts per week (1 ounce per serving) was associated with reduced risk of developing impairments in physical function in older women, which may help to maintain independence throughout the aging process.⁶ Researchers looked at data from 54,762 women in the prospective Nurses' Health Study, which tracked women for more than 30 years. This paper emphasised that overall diet quality, rather than individual foods, may have a greater impact on reducing risk of physical function impairments. Specifically, diet quality traits most associated with reduced rates of incident physical impairment were higher intake of fruits and vegetables; lower intake of sugar-sweetened beverages, trans fat, and sodium; and moderate alcohol intake. Among food components, the strongest relations were found for increased intakes of walnuts, oranges, orange juice, apples, pears and romaine or leaf lettuce.

Residual confounding cannot be ruled out (i.e., other lifestyle habits which are more common in adults who eat walnuts could contribute to the study results) and findings cannot prove causality in observational studies.^{2,6} More research is also needed to clarify how the health benefits apply to other populations.^{2,6} In the context of a Mediterranean diet, it is difficult to precisely define what part of the diet is associated with cognitive health.²

¹Poulose SM, Miller MG, Shukitt-Hale B. Role of walnuts in maintaining brain health with age. *J Nutr.* 2014;144(4 Suppl):561S-566S. ²Valls-Pedret C, Sala-Vila A, Serra-Mir M, et al. Mediterranean diet and age-related cognitive decline: a randomised clinical trial. *JAMA Intern Med.* 2015;175(7):1094-103. ³Arab L, Ang A. A cross sectional study of the association between walnut consumption and cognitive function among adult us populations represented in NHANES. *J Nutr Health Aging.* 2015;19(3):284-90. ⁴Muthaiyah B, Essa MM, Lee M, et al. Dietary supplementation of walnuts improves memory deficits and learning skills in transgenic mouse model of Alzheimer's disease. *J Alzheimers Dis.* 2014;42(4):1397-405. ⁵Chauhan N, Wang KC, Wegiel J, et al. Walnut extract inhibits the fibrillization of amyloid beta-protein, and also defibrillizes its preformed fibrils. *Curr Alzheimer Res.* 2004;1(3):183-8. ⁶Hagan KA, Chiuve SE, Stampfer MJ, et al. Greater adherence to the alternative healthy eating index is associated with lower incidence of physical function impairment in the nurses' health study. *J Nutr.* 2016;146(7):1341-47.



Spinach, Walnut and Strawberry Salad

WALNUTS & CANCER

PRELIMINARY ANIMAL AND CELL

model research has been investigating the potential benefit walnuts may have on a variety of cancers including breast, prostate and colorectal. Please note that the following animal and cell studies are provided as background and used to formulate hypotheses for additional research needed to determine the effects on humans.

A review of animal research published in *The Journal of Nutrition* demonstrates that walnuts may have multiple nutrients that could act in various ways to help decrease the risk of developing cancer. The studies reviewed suggest that these nutrients act together to provide more benefit than would be expected from the individual components.¹

BREAST CANCER

ANIMAL RESEARCH PUBLISHED in *Nutrition and Cancer* looked at the role of walnut consumption on potential breast cancer protection in maternal mice and their offspring. Researchers found that a diet including a modest amount of walnuts (equivalent to 2 ounces per day for humans) was associated with a decreased risk of breast cancer in mice.² Maternal mice were randomised to a control diet with corn oil or a diet containing walnuts, and both diets were designed to be isocaloric and isonutrient. The maternal mice were then bred with male mice and the offspring were randomised to the same two diets after weaning. The findings showed a significant reduction in tumor incidence, number and size in maternal and offspring mice that consumed walnuts compared to mice that did not consume walnuts. Although more research is needed to determine the specific components of walnuts and the mechanisms associated with tumor suppression, the findings demonstrate that walnuts may contribute to a healthy diet to reduce risk for breast cancer in mice.



Avocado Walnut Toast

COLORECTAL CANCER

AN ANIMAL STUDY PUBLISHED in *Cancer Prevention Research* found that eating walnuts could modify gut bacteria in a way that is beneficial to colon health, and may be associated with colon tumor suppression.³ In the study, researchers incorporated walnuts into two different diets, a standard mouse diet supplemented with 0, 15, 22.5, or 30.2 percent of calories from walnuts, and a Western diet, representing typical American intake, supplemented with 0, 5.2, 10.5, or 21.4 percent of calories from walnuts. Calories from fat sources were proportionally lowered in each diet to compensate for the addition of walnuts. Male mice fed a Western diet with 10.5 percent of total calories from walnuts, which translates to just over one ounce of walnuts in a human diet, showed a significant reduction in the number and size of tumors.

ANIMAL RESEARCH CONDUCTED at the Beth Israel Deaconess Medical Center and Harvard Medical School demonstrated that walnuts in the diet may inhibit colorectal cancer growth in mice by suppressing angiogenesis.⁴ In this study, mice with human colon cancer cells were randomised to diets containing approximately 19 percent of total energy from corn oil (control diet), flaxseed oil or ground walnuts (approximately 2 ounces of walnuts in a human diet). Compared with the corn oil diet, mice fed the walnut diet (equivalent to 2 servings of walnuts per day in humans) or flaxseed diet exhibited significantly slower tumor growth rates and lower tumor weights. The differences between walnut and flaxseed diets did not reach statistical significance. However, compared to the control-fed mice, consumption of walnuts significantly decreased angiogenesis which may be beneficial against the progression of colorectal cancer.

PROSTATE CANCER

WALNUTS CONTAIN SEVERAL BIOACTIVE compounds including ellagitannins (ETs), a type of polyphenol. After consumption, ETs are metabolised to release ellagic acid (EA), which is further metabolised by gut microbiota to form urolithins, such as A (UA) and B (UB).

A CELL STUDY PUBLISHED in the *European Journal of Nutrition* looked at gene expression in prostate cancer cells and found that UA, the main human metabolite of walnut polyphenols, may help to inhibit or reduce the risk of prostate cancer from developing.⁵ Similarly, another cell study showed that a diet rich in ET-containing foods, such as walnuts, could contribute to the prevention of prostate cancer by influencing the regulatory mechanisms in prostate cancer.⁶

RESEARCH PUBLISHED IN CANCER INVESTIGATION showed that walnuts may help reduce prostate cancer risk in mice.⁷ In this experimental study, mice were fed either a

standard mouse diet (control diet) or a standard mouse diet enriched with walnuts (equivalent to 2 ounces of walnuts per day in humans). The final average tumor size in the walnut-fed mice was approximately 25 percent the average size of the prostate tumors that developed in the mice that consumed the non-walnut control diet.

¹Hardman, WE. Walnuts have potential for cancer prevention and treatment in mice. *J Nutr.* 2014;144(4 Suppl):555S-560S. ²Hardman WE, Ion G, Akinsete JA, et al. Dietary walnut suppressed mammary gland tumorigenesis in the C(3)1 TAg mouse. *Nutr Cancer.* 2011;63(6):960-70. ³Nakanishi M, Chen Y, Qendro V, et al. Effects of walnut consumption on colon carcinogenesis and microbial community structure. *Cancer Prev Res (Phila).* 2016;9(8):692-703. ⁴Nagel JM, Brinkoetter M, Magkos F, et al. Dietary walnuts inhibit colorectal cancer growth in mice by suppressing angiogenesis. *Nutrition.* 2012;28(1):67-75. ⁵Sánchez-González C, Ciudad CJ, Izquierdo-Pulido M, et al. Urolithin A causes p21 up-regulation in prostate cancer cells. *Eur J Nutr.* 2016;55(3):1099-112. ⁶Sánchez-González C, Ciudad CJ, Noé V, et al. Walnut polyphenol metabolites, urolithins A and B, inhibit the expression of the prostate-specific antigen and the androgen receptor in prostate cancer cells. *Food Funct.* 2014;5(11):2922-30. ⁷Reiter RJ, Tan DX, Manchester LC, et al. A walnut-enriched diet reduces the growth of LNCaP human prostate cancer xenografts in nude mice. *Cancer Invest.* 2013;31(6):365-73.

WALNUTS & DIABETES AND METABOLIC SYNDROME

INDIVIDUALS WITH DIABETES or metabolic syndrome often have conditions such as elevated blood pressure, cholesterol, or triglycerides, which can increase the risk for heart disease and stroke. Research on the association between walnut consumption and these conditions demonstrate the importance of walnuts as part of a healthy diet to help manage complications associated with diabetes and metabolic syndrome.



AN EPIDEMIOLOGICAL STUDY representing more than 34,000 American adults suggests that those who consume walnuts may have about half the risk of developing type 2 diabetes compared to adults who do not eat nuts.¹ Researchers from the University of California Los Angeles looked at data from the National Health and Nutrition Examination Survey (NHANES), in which adults (ages 18-85 years old) were asked about their dietary intake over the course of one to two days and assessed for diabetes. According to the study, the average intake among walnut consumers was approximately one and a half tablespoons per day. Doubling walnut consumption (eating three tablespoons) was associated with a 47% lower prevalence of type 2 diabetes. The study did not look at the impact of increasing walnut consumption beyond doubled intake.



RESEARCHERS FROM HARVARD found that walnut consumption was associated with a significantly lower risk of type 2 diabetes in women who regularly consumed walnuts compared with women who never/rarely consumed walnuts.² The study looked at two large prospective cohorts of U.S. women: The Nurses' Health Study (NHS) and NHS II, which followed 58,063 women (ages 52-77) in NHS (1998-2008) and 79,893 women (ages 35-52) in NHS II (1999-2009) without diabetes,

cardiovascular disease or cancer at baseline. They found two or more servings (1 serving is equivalent to 1 ounce) of walnuts per week, as part of a healthy diet, was associated with a 21 percent and 15 percent lower risk of incident type 2 diabetes before and after adjusting for body mass index (BMI), respectively.



A STUDY PUBLISHED in *Metabolism* found that short-term consumption of walnuts may improve blood lipids, by increasing apolipoprotein A concentration.³ Apolipoprotein A is the primary protein component of HDL, and is one of many factors that may be considered in a complete lipid profile when estimating cardiovascular disease risk. For this study, 15 obese subjects (ages 56-61) with metabolic syndrome were enrolled in a randomised, double-blinded, placebo-controlled crossover study in which they consumed two different isocaloric diets, one with 48 grams of walnuts daily (approximately 1.7 ounces) and one without walnuts for four days each. The results suggest that eating walnuts may have a beneficial effect on lipid metabolism even within short-term consumption.



FINDINGS FROM THE YALE UNIVERSITY'S Yale-Griffin Prevention Research Center demonstrated that consumption of a diet enriched with two ounces of walnuts per day for eight weeks significantly improved endothelial function in 24 adult participants (ages 49-67) with type 2 diabetes.⁴ Subjects were randomly assigned to an *ad libitum* diet enriched with 56 grams of walnuts per day or an *ad libitum* diet without walnuts. Researchers compared the dietary effects on endothelial function, a measure of how well blood vessels are able to dilate, resulting in increased blood flow, and a powerful predictor of overall cardiovascular risk. The same design was used

in another study with 46 overweight adults with elevated waist circumference and one or more additional signs of metabolic syndrome. Findings showed that daily consumption of 56 grams of walnuts for eight weeks significantly improved endothelial function as compared with an *ad libitum* diet not supplemented with walnuts.⁵

Research has found that including the right type of fats, like those found in walnuts, can be beneficial to people with diabetes.

Larger and longer-term studies, as well as studies in more diverse populations, are needed to clarify population-wide effects. In some cases, residual confounding cannot be

ruled out (i.e., other lifestyle factors which are more common in adults who eat walnuts could contribute to the study results).^{1,3,4}

¹Arab L, Dhaliwal SK, Martin CJ, et al. Association between walnut consumption and diabetes risk in NHANES [published online ahead of print June 21, 2018]. *Diabetes Metab Res Rev*. doi.org/10.1002/dmrr.3031

²Pan A, Sun Q, Manson JE, et al. Walnut consumption is associated with lower risk of type 2 diabetes in women. *J Nutr*. 2013;143(4):512-8.

³Aronis KN, Vamvini MT, Chamberland JP, et al. Short-term walnut consumption increases circulating total adiponectin and apolipoprotein A concentrations, but does not affect markers of inflammation or vascular injury in obese humans with the metabolic syndrome: data from a double-blinded, randomised, placebo-controlled study. *Metabolism*. 2012;61(4):577-82.

⁴Ma Y, Njike VY, Millet J, et al. Effects of walnut consumption on endothelial function in type 2 diabetic subjects: a randomised controlled crossover trial. *Diabetes Care*. 2010;33(2):227-32.

⁵Katz DL, Davidhi A, Ma Y, et al. Effects of walnuts on endothelial function in overweight adults with visceral obesity: a randomised, controlled, crossover trial. *J Am Coll Nutr*. 2012 Dec;31(6):415-23.



**Thai Walnut
BBQ Chicken Bowl**

WALNUTS & WEIGHT

A SHORT-TERM STUDY from researchers at Beth Israel Deaconess Medical Center and Harvard Medical School found that walnuts may increase satiety and sense of fullness.¹ Twenty men and women (ages 57-61) with metabolic syndrome participated in this randomised, double blind, cross-over study. For four days, subjects consumed isocaloric diets including a liquid meal containing either 48g of walnuts (approximately 1.7 ounces) or no walnuts. Both meals had similar macronutrient composition with the placebo rich in monounsaturated fats (MUFAs) and the walnut meal being rich in polyunsaturated fats (PUFAs). By day three of the study, subjects on the walnut-containing diet reported feeling more satiated and had a significantly higher rate of feeling full compared to those on the placebo diet. Due to the short study duration, longer-term studies are needed to explore the role of walnuts on these outcomes.

A STUDY PUBLISHED in *Nutrition* showed that healthy adults (ages 18-35) who regularly consume foods that contain PUFAs may experience favorable changes in appetite hormones associated with hunger and satiety.² Twenty-six participants consumed test meals high in saturated fat at the beginning of the study and then were placed on a seven-day control diet consisting of a typical American eating pattern or a diet high in PUFAs (included whole foods such as walnuts, Alaska salmon, tuna, flaxseed oil, grapeseed oil, canola oil, and fish oil supplements). After the seven-day diet, participants consumed meals high in saturated fat, again. Study participants that consumed a PUFA-rich diet had a significant decrease in fasting ghrelin, a hormone that increases hunger, and a significant increase in peptide YY (PYY), a hormone that increases fullness or satiety. Participants saw increases in PYY while fasting and after consuming a meal. These types of hormone changes could help with better appetite control although it is difficult to discern whether the changes can be attributed to one specific type of PUFA, food source, or a combination of overall dietary factors.

PUBLISHED RESEARCH FROM the *Journal of the American Heart Association* and *Metabolism* found that a diet containing unsaturated fats, such as those found in walnuts and olive oil, may have similar effects on weight loss as compared to a lower fat, higher carbohydrate diet among overweight and obese women.^{3,4} Two hundred forty-five women (ages 22-72) were enrolled in a one-year behavioural weight loss intervention and randomly assigned to three different diets: 1) a lower fat, higher carbohydrate diet (excluded nuts), 2) a lower carbohydrate, higher fat diet (excluded nuts), or 3) a walnut-rich (1.5 ounces per day), higher fat, lower carbohydrate diet. Participants were instructed to reduce energy intake by 500-1000 calories per day and also received dietary guidance from a dietitian.

A similar study found that a walnut-enriched, reduced-calorie diet also had similar effects on weight loss compared to a standard reduced-calorie diet among overweight and obese adults.⁵ One-hundred participants (average age 52-53) were enrolled in a six-month behavioural weight loss intervention and were instructed to reduce their daily caloric intake by 500-1000 calories with additional dietary guidance provided by a dietitian. Those on the walnut-enriched diet consumed 28-42 grams (1-1.5 ounces) of walnuts per day depending on the caloric restriction. Weight loss was similar across all diet groups, demonstrating that walnuts may play a role in achieving ideal body weight, when consumed as part of an overall healthy diet.



**Toasted Walnut,
Black Bean, Corn
and Tomato Salad**

A FRESH LOOK AT THE CALORIE CONTENT OF WALNUTS

A STUDY FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE (USDA) found that one serving of walnuts (1 ounce) may provide 146 calories, which is 39 calories less, or 21 percent fewer, than the 185 calories listed in the USDA Nutrient Database.⁶ Eighteen healthy adults were randomly assigned to a sequence of two isocaloric diets: A controlled American diet without walnuts for a three-week period, and a controlled diet with 1.5 servings of walnuts (1.5 ounces) for another three-week period. Bomb calorimetry was used to measure calories and then the data was used to calculate the metabolisable energy of the walnuts. The study took into account the digestibility of walnut pieces and halves and further research is needed to better understand the results of the study and how this technique for calculating calories could potentially affect the calorie count of other foods.

that participants paid more attention to food choices after eating walnuts. Longer-term studies in more diverse populations are needed to confirm results.

Another study, published in *Circulation*, used imaging technology to map body organ fat storage pools in 278 participants (ages 28-69; mostly male and obese) following two types of diet: a Mediterranean, low-carbohydrate diet that included one ounce (28g) of walnuts per day or a low-fat diet, with and without moderate exercise.⁸ After following the diets for 18 months, the Mediterranean, low-carbohydrate diet with walnuts was found to be most effective in reducing fat deposits around the liver, abdomen, and heart. Adding exercise provided additional benefit for visceral fat loss in all groups. Total lean body mass or fat mass measurements were not available from the MRI analysis. Since this intervention involved dietary and physical activity changes, it is difficult to identify the exact factors responsible for the effects.

Information on dietary intake and diet adherence may have been limited in studies where participants were free-living and data was self-reported. Although larger and longer-term studies, as well as studies in more diverse populations, are needed to understand population-wide effects, walnuts can play a role in optimal body weight, when consumed as part of a healthy diet.

RESEARCHERS HAVE ALSO USED MAGNETIC RESONANCE IMAGING (MRI) to explore possible connections between walnut consumption and important functions in the body. Researchers from the Beth Israel Deaconess Medical Center found that eating walnuts may activate an area in the brain associated with hunger and cravings.⁷ Ten obese adult participants (ages 48-54) lived at the medical centre for two 5-day sessions and were closely monitored for food intake and appetite. Participants reported feeling fuller when they consumed a daily smoothie with 48 grams of walnuts (approximately 1.7 ounces), compared to when they consumed a placebo smoothie with the same macronutrient content but with safflower oil instead of walnuts. Researchers saw increased activity in a part of the brain that is thought to be involved in cognitive control and salience, suggesting

¹Brennan AM, Sweeney LL, Liu X, et al. Walnut consumption increases satiation but has no effect on insulin resistance or the metabolic profile over a 4-day period. *Obesity (Silver Spring)*. 2010;18(6):1176-82. ²Stevenson JL, Paton CM, Cooper JA. Hunger and satiety responses to high-fat meals after high polyunsaturated fat diet: a randomised trial. *Nutrition*. DOI: <http://dx.doi.org/10.1016/j.nut.2017.03.008> ³Rock CL, Flatt SW, Pakiz B, et al. Effects of diet composition on weight loss, metabolic factors and biomarkers in a 1-year weight loss intervention in obese women examined by baseline insulin resistance status. *Metabolism*. 2016;65(11):1605-13. ⁴Le T, Flatt SW, Natarajan L, et al. Effects of diet composition and insulin resistance status on plasma lipid levels in a weight loss intervention in women. *J Am Heart Assoc*. 2016;25;5(1):e002771. ⁵Rock CL, Flatt SW, and Barkai HS. Walnut consumption in a weight reduction intervention: effects on body weight, biological measures, blood pressure and satiety. *Nutr J*. 2017;16(76). ⁶Baer DJ, Gebauer SK, Novotny JA. Walnuts consumed by healthy adults provide fewer available calories than predicted by the atwater factors. *J Nutr*. 2016;146(1):9-13. ⁷Farr OM, Tuccinardi D, Upadhyay J, et al. Walnut consumption increases activation of the insula to highly desirable food cues: A randomised, double-blind, placebo-controlled, cross-over fMRI study. *Diabetes Obes Metab*. 2018;20(1):173-177. ⁸Gepner Y, Shelef I, Schwarzfuchs D, et al. Effect of Distinct Lifestyle Interventions on Mobilization of Fat Storage Pools: CENTRAL Magnetic Resonance Imaging Randomised Controlled Trial. *Circulation*. 2018;137(11):1143-1157.

WALNUTS & GUT HEALTH

EMERGING RESEARCH ON THE GUT MICROBIOME suggests walnuts may be one food to consider for gut health due to their prebiotic potential and possible role in providing a variety of associated health benefits.

A STUDY FROM THE USDA AND UNIVERSITY OF ILLINOIS, published in *The Journal of Nutrition*, found that walnut consumption was associated with positive changes to the gut microbiome.¹ A small sample of 18 healthy adults (ages 35-68) who ate 42 grams (about 1.5 ounces) of walnuts each day for three weeks experienced a decrease in secondary bile acids, which may play a role in colon cancer, inflammation, and gastrointestinal diseases. The study also found that eating walnuts resulted in an increase in gut bacteria that is thought to be beneficial for health.

Asian Walnut Chicken Veggie Noodle Jar



ANOTHER STUDY, PUBLISHED IN *NUTRIENTS*, FOUND THAT CONSUMING A WALNUT-ENRICHED DIET POSITIVELY IMPACTED THE GUT MICROBIOME by enhancing good probiotic- and butyric acid-producing bacteria.² Butyric acid is thought to be useful for digestive health by helping to maintain the health of the colon. The study included 194 healthy German adults (mean age of 63 years old) randomised into two different diet phases, each lasting for eight weeks. One group followed a walnut-enriched diet that included 43 grams (about 1.5 ounces) of walnuts per day and then switched to a nut-free diet. The other group followed the diets in reverse order. During the walnut diet, participants were also randomised to reduce their intake of carbohydrates, fat, or both under the advisory of a nutritionist.

Larger and longer-term studies are needed to clarify these effects in a broader population, and future research is needed to understand how specific bacterial species may be associated with favorable health effects, such as heart health.

Evidence from two animal studies also suggest an association between walnut consumption and a healthier gut.

A STUDY PUBLISHED IN *THE JOURNAL OF NUTRITIONAL BIOCHEMISTRY* FOUND THAT WALNUT CONSUMPTION MAY BE BENEFICIAL for digestive health by increasing the amount of probiotic-type bacteria in the gut.³ In this study, rats were randomly assigned to a diet containing ground walnuts, equivalent to about two ounces per day in humans, or a diet without walnuts for up to 10 weeks. Calorie and nutrient intake was similar between the two groups. Compared to those that did not consume walnuts, rats that ate a walnut-enriched diet saw an increase in beneficial bacteria including, *Lactobacillus*, *Roseburia*, and *Ruminococcaceae*.



ANOTHER ANIMAL STUDY PUBLISHED IN *CANCER PREVENTION RESEARCH* FOUND THAT EATING WALNUTS MAY MODIFY GUT BACTERIA in mice to support colon health, which is considered when looking at the ability to protect against colon tumors.⁴ Researchers incorporated walnuts into two different diets: a standard mouse diet which is widely used in animal studies, and a Western diet representing typical American intake. Male mice fed the Western diet with 10.5 percent of total calories from walnuts, translating to just over one ounce of walnuts in a human diet, showed a significant reduction in the number and size of tumors. There was also a modest reduction in the number and volume of tumors in mice that consumed the standard diet with 15 percent of total calories from walnuts.

These animal studies provide background that can be used to inform future studies needed to understand the effect on humans. Researchers studied mice that had colon cancer, which may have altered the normal function of the gut microbiome.

¹ Holscher HD, Guetterman HM, Swanson KS, et al. Walnut Consumption Alters the Gastrointestinal Microbiota, Microbially Derived Secondary Bile Acids, and Health Markers in Healthy Adults: A Randomised Controlled Trial. *J Nutr*. 2018;148(6):861-867.

² Bamberger C, Rossmeier A, Lechner K, et al. A Walnut-Enriched Diet Affects Gut Microbiome in Healthy Caucasian Subjects: A Randomised, Controlled Trial. *Nutrients*. 2018;10(2): 244.

³ Byerley LO, Samuelson D, Blanchard E, et al. Changes in the Gut Microbial Communities Following Addition of Walnuts to the Diet. *J Nutr Biochem*. 2017;48:94-102.

⁴ Nakanishi M, Chen Y, Qendro V, et al. Effects of walnut consumption on colon carcinogenesis and microbial community structure. *Cancer Prev Res (Phila)*. 2016;9(8):692-703.



Toasted Walnut Hummus



WALNUTS & REPRODUCTIVE HEALTH

THE AMERICAN SOCIETY FOR REPRODUCTIVE MEDICINE has found evidence that infertility affects men and women equally with about one-third of infertility cases being attributed to male factors, and about one-third to factors that affect women.¹ Throughout history, food has been linked with human reproductive success, however most emphasis has been on the maternal diet and little focus has been given to the paternal diet.

Findings from walnut health studies have provided encouraging results regarding men's reproductive health research and walnuts may play a role.

A study of healthy young men (ages 21-35) who ate 75 grams (approximately 2.5 ounces) of walnuts per day experienced positive shifts in sperm quality factors, including sperm vitality, motility (movement) and morphology (form).² Sperm quality is an indicator of male fertility.³ This randomised, parallel two-group dietary intervention trial included 117 participants who routinely ate a Western-style diet. Approximately half were assigned to consume 75 grams of walnuts per day for 12 weeks as part of their usual diet, while the remaining half followed their typical diet but avoided consumption of tree nuts.

Consuming walnuts may have contributed to shifts in certain sperm quality factors in these healthy young men, but more research is needed to understand how these findings impact the broader male population, including men in fertility clinics. This study also reported higher amounts of alpha-Linolenic acid (ALA) provided by walnuts correlated with less frequent sperm aneuploidy (abnormal cell chromosome numbers), which can result in genetic abnormalities such as Down syndrome.

Walnuts are the only nut with an excellent source of ALA, the plant-based omega-3 fatty acid (2.5 grams/ounce).

Another study, in an animal model, explored possible mechanistic reasons for the results seen in the clinical trial. Mice fed a walnut-rich diet showed a reduction in lipid peroxidation, a process that can damage sperm cells.⁴ This form of cell damage harms sperm membranes, which are primarily made up of polyunsaturated fatty acids (PUFAs). Previous studies have shown that PUFAs may play a role in sperm health and membrane function. Walnuts are the only tree nut that are predominantly comprised of PUFAs (1 ounce contains 13 grams of PUFAs out of 18 grams of total fat), which is why they were included in this study. This promising animal research provides important insight, but the results are inconclusive regarding the effects on humans and how PUFAs function to reduce lipid peroxidation. Future human clinical studies are needed.

Additional limitations should be considered for the clinical trial. Information on dietary intake and adherence was limited since participants were free-living and self-reported data. Collection of blood specimens for hormone analysis occurred throughout the day, to accommodate busy schedules of the subjects, but participants were asked to attend follow-up appointments at similar times for consistent data collection.

¹FAQs About Infertility. American Society for Reproductive Medicine. <http://www.reproductivefacts.org/faqs/frequently-asked-questions-about-infertility/>. Accessed September 18, 2017. ² Robbins WA, Xun L, FitzGerald LZ, et al. Walnuts improve semen quality in men consuming a Western-style diet: randomised control dietary intervention trial. *Biol Reprod.* 2012;87(4):101. ³ World Health Organization. Laboratory Manual for the Examination and Processing of Human Semen, 5th ed. Cambridge, UK: Cambridge University Press; 2010. ⁴ Coffua LS, Martin-DeLeon PA. Effectiveness of a walnuts-enriched diet on murine sperm: involvement of reduced peroxidative damage. *Heliyon.* 2017;3(2).

MEDITERRANEAN DIET & HEALTH

THERE ARE VARIOUS FORMS of the Mediterranean diet, which emphasises more fruits and vegetables, nuts and seeds (including walnuts), grains, olive oil, moderate amounts of fish, poultry, eggs and wine, and limits the amounts of red meat, processed meat, dairy and sweets.¹ The NHS Eatwell Guide recommends a Mediterranean-style eating pattern as one example of a healthy diet plan.²

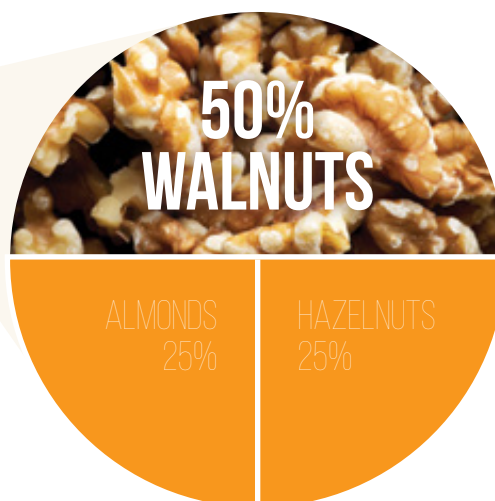
PREDIMED (PREvención con Dieta MEDiterránea = Prevention with Mediterranean Diet) was a landmark study aimed at assessing the efficacy of the Mediterranean diet in the primary prevention of cardiovascular disease.³ Researchers examined whether a Mediterranean diet supplemented with extra-virgin olive oil or mixed tree nuts (50% walnuts, 25% almonds, and 25% hazelnuts), compared to a low-fat diet, could help reduce the risk of major cardiovascular events, including cardiovascular death, myocardial infarction (heart attack) and stroke. The study was a parallel group,

multi-centre, single blind, randomised clinical trial that was conducted by 16 research groups and seven communities and supported by the Spanish Health Ministry. Participants included 7,447 Spanish individuals (ages 55-80) at high risk of cardiovascular disease, but without symptoms at baseline, and were followed for a median of 4.8 years. Subjects were randomly assigned to one of three diet groups, content listed below, and were given dietetic support and educational sessions to ensure compliance. Energy intake was not specifically restricted in any intervention group.

A Mediterranean diet including tree nuts, primarily walnuts, was associated with a 30 percent lower risk of cardiovascular events (myocardial infarction, stroke or cardiovascular death) and specifically, a 46 percent lower risk of stroke, when compared to a low-fat diet.

PREDIMED DIET GROUPS

1. Mediterranean diet supplemented with **MIXED NUTS** (30 g per day; 15g walnuts (about 0.5 ounces), 7.5g almonds and 7.5g hazelnuts)
2. Mediterranean diet supplemented with **EXTRA VIRGIN OLIVE OIL** (at least 50g or 4 tablespoons per day)
3. **LOW-FAT DIET** (control group; American Heart Association guidelines)



The Mediterranean diet enriched with extra-virgin olive oil also reduced the risk of cardiovascular diseases by 30 percent. More than 300 additional publications have resulted from the PREDIMED research investigating outcomes such as cognitive function,⁴ blood pressure,⁵ total cholesterol,⁵ and fasting glucose.⁵

The study had some limitations including the fact that participants lived in a Mediterranean country and were at high risk for cardiovascular disease. More research is needed to clarify the health benefits in other populations. Additionally, it is difficult to precisely define what part of the Mediterranean diet was associated with cardiovascular benefits.

The seminal paper, “Primary Prevention of Cardiovascular Disease with a Mediterranean Diet,” was originally published in 2013, but was withdrawn from the *New England Journal of Medicine* (NEJM) in 2018 due to irregularities in the randomisation procedures. The researchers reanalysed the data and

the updated manuscript was subsequently republished in the *NEJM*. There were no significant changes to the findings, despite the revised randomisation methods.

Interested in more resources? Oldways,⁶ an non-profit food and nutrition education organisation, has created numerous helpful resources on the Mediterranean diet.

¹Willett WC, Sacks F, Trichopoulos A, et al. Mediterranean diet pyramid: a cultural model for healthy eating. *Am J Clin Nutr* 1995;61(6 Suppl):1402S-1406S.

²NHS Eatwell Guide: Available at <https://www.nhs.uk/live-well/eat-well/what-is-a-mediterranean-diet/>

³Estruch R, Ros E, Salas-Salvadó J, et al. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet Supplemented with Extra-Virgin Olive Oil or Nuts. *N Engl J Med*. 2018;378(25):e34. doi: 10.1056/NEJMoa1800389.

⁴Valls-Pedret C, Sala-Vila A, Serra-Mir M, et al. Mediterranean diet and age-related cognitive decline: a randomised clinical trial. *JAMA Intern Med*. 2015;175(7):1094-103.

⁵Doménech M, Roman P, Lapetra J, et al. Mediterranean diet reduces 24-hour ambulatory blood pressure, blood glucose, and lipids: one-year randomised, clinical trial. *Hypertension*. 2014 Jul;64(1):69-76.

⁶<http://www.oldwayspt.org/>





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