Background paper

DATE: August 2013

AUTHOR: Elisabeth Weichselbaum, PhD, MSc

DIETARY PATTERNS AND THE HEART

This background paper presents the evidence for the Heart Foundation's recommendations on dietary patterns that support heart health

Contents

Contents 1

Executive Summary 2

Recommendations 5

For health professionals 5

Background 7

Introduction 8

Typical dietary patterns in New Zealand 9

Evidence overview 10

Nature of Evidence 10

Mediterranean Diet 10

Vegetarian Diet 17

DASH Diet 24

Prudent Diet vs. Western Diet 31

Asian Diets 36

Japanese Diet 36

Chinese Dietary Patterns 38

Other Asian Diets 42

Adherence to Dietary Guidelines and Recommendations 43

Putting the Findings into Context 47

Conclusion 53

Acknowledgements 53

References 54

Executive Summary

It is the overall diet, as well as single dietary components, that impact on health status and risk of disease, including cardiovascular disease (CVD). Many studies have investigated the association between dietary patterns and risk of disease. This paper reviews the latest evidence on dietary patterns and CVD, including heart disease and stroke.

Overall, this review of the evidence found:

- Various dietary patterns are associated with a reduced risk of CVD, including coronary heart disease (CHD) and stroke. These include the Mediterranean, vegetarian, DASH and prudent dietary patterns.

- Dietary patterns that have a protective effect on cardiovascular health share several features, including a large proportion of plant foods in the diet, wholegrain varieties of foods, fish and/or legumes, plant oils, and nuts. Certain animal products, particularly those high in fat and saturated fat, and foods high in refined carbohydrates, sugar and fat are usually limited or completely excluded in these types of dietary pattern.

- People who eat a healthier diet also tend to lead a healthier lifestyle, explaining some but not all of the observed protective associations.

- A Western dietary pattern, characterised by a high proportion of foods such as red meat, processed meat, refined grains, sweets and desserts, hot chips, and high-fat dairy products, has been associated with an increased risk of CHD and stroke.

The specific findings relating to the various dietary patterns are:

Mediterranean diet:

- The Mediterranean diet is characterised by a high intake of vegetables, legumes, fruits and nuts, cereals (largely unrefined), and olive oil, a moderately high intake of fish, a low-to-moderate intake of dairy products, a low intake of meat and poultry, and a regular but moderate intake of alcohol.

- Increased adherence to the Mediterranean diet seems to decrease the risk of CVD in primary and in secondary prevention.

- In US cohorts those who adhered more closely to a Mediterranean style diet tended to lead a healthier lifestyle, which

explained some of the association with lower risk of CVD. However, in Mediterranean populations other lifestyle factors were unrelated to the observed risk reduction, suggesting that the Mediterranean diet *per se* had a protective effect.

- There is also some evidence that it reduces the risk of developing metabolic syndrome and has a protective effect on most individual components of the metabolic syndrome.

Vegetarian diet:

- Vegetarian diets do not contain meat, poultry or fish; vegan diets further exclude dairy products and eggs. Although a vegetarian can be equally unbalanced as any other diet, people who follow a vegetarian diet generally have higher intakes of plant foods including fruits, vegetables, legumes and nuts, which have been associated with a protective effect on health.

- A vegetarian diet is associated with lower ischaemic heart disease (IHD) mortality risk (more so in vegans), but does not seem to be associated with cerebrovascular mortality.

- Vegetarians and vegans tend to lead a healthier life overall, explaining some but not all of the lower risk observed in these groups.

- Vegetarians, and in particular vegans, generally have lower triglyceride, total and LDL cholesterol levels than non-vegetarians.

- Blood pressure levels are lower in vegetarians (more so in vegans) compared to non-vegetarians; however, much of this effect can be explained by the lower body mass indexes (BMIs) of vegetarians, and in particular of vegans.

- People eating a vegetarian diet seem to have a lower risk of developing type 2 diabetes. A vegetarian diet also seems to be effective in the treatment of type 2 diabetes.

DASH diet:

- The DASH diet (short for Dietary Approaches to Stop Hypertension) has specifically been developed to lower blood pressure levels. It is a diet low in saturated fat, cholesterol and total fat, and emphasises fruit, vegetables, and fat-free or low-fat milk and milk products. It also includes whole grain products, fish, poultry, and nuts.

- The DASH diet has been associated with lower risk of CHD, although some studies using a more stringent DASH score have not found an association.

- The DASH diet is effective in reducing blood pressure in subjects with elevated blood pressure levels, more so when sodium intake is reduced as well.

- The DASH diet has been found to reduce blood levels of total and LDL cholesterol, but also HDL cholesterol.

Prudent versus Western diet:

- The prudent dietary pattern is one that complies well with healthy eating recommendations and typically is high in foods such as vegetables, legumes, fruit, fish and shellfish, poultry, wholegrains and low-fat dairy products. In contrast, the Western dietary pattern is characterised by a higher intake of foods such as red meat, processed meat, refined grains, sweets and desserts, hot chips, and high-fat dairy products.

- Evidence from US based studies suggests that a prudent dietary pattern is associated with a lower risk of CHD, and possibly stroke, whereas a Western dietary pattern is associated with an increased CVD risk. Findings from European studies do not support an association, possibly because the prudent and Western dietary patterns observed in Europe are different to those observed in the US.

- Findings from a small number of US based studies do not suggest that a prudent dietary pattern is associated with risk of type 2 diabetes, but that a Western dietary pattern is associated with an increased risk of type 2 diabetes.

- A Western dietary pattern may be associated with an increased risk of metabolic syndrome.

Asian diet:

- There is limited evidence suggesting that a Japanese dietary pattern may be beneficial for cardiovascular health, although findings have been inconsistent.

- A Japanese dietary pattern is characterised by high intakes of soybean products, fish, seaweeds, vegetables, fruits and green

tea, and by a high salt consumption through high intakes of soy sauce, salty soups and various other condiments high in salt.

- A diet typical for Northern China, which is high in staple foods including grains and starchy root vegetables, and low in protein-sources, has been associated with a higher risk of stroke compared to a diet typical for Southern China, which is high in rice, vegetables, seafood, pork and poultry.

These findings are in accordance with the previous position statement, which also found a protective effect of traditional Mediterranean, vegetarian, Asian and modified Western dietary patterns on heart disease.

Recommendations

There are a number of traditional and modified dietary patterns associated with a reduced risk of heart disease. These dietary patterns include the prudent (similar to dietary guidelines) diet, the Mediterranean diet, a vegetarian diet, or the DASH diet.

The main features of these dietary patterns can be applied to create a heart healthy diet. They typically contain plenty of vegetables and fruit, wholegrain varieties of foods, fish and/or legumes, plant oils, and nuts.

Specific benefits of these dietary patterns are:

- The Mediterranean diet is associated with a lower risk of CVD in the general population. It has also been found to lower risk of CVD, and to improve cardiovascular risk factors including blood pressure, cholesterol levels and blood glucose levels in high risk subjects.
- Vegetarian or vegan diets are associated with a lower risk of CVD in the general population. They seem to be more effective in improving total and LDL cholesterol levels than a balanced diet that also includes meat, but HDL cholesterol levels are reduced as well. However, total and LDL cholesterol levels were clearly more affected by a vegetarian diet than HDL cholesterol, and it can be expected that the ratio will decline.
- The DASH diet is effective in reducing blood pressure levels, particularly when sodium intake is reduced at the same time. The DASH diet also seems to lower total and LDL cholesterol levels, but also HDL cholesterol level, but has no significant effect on total to HDL cholesterol ratio.

For health professionals

To reduce the risk of heart disease in both normal and high risk patients, it is recommended to advise people to follow a heart healthy dietary pattern. Dietary patterns associated with a reduced risk of heart disease include the

Mediterranean diet, vegetarian diet, and probably the prudent, Asian or DASH diet. The heart healthy aspects of these diets are their high content of plant-based foods such as vegetables and fruit, legumes, nuts and healthy oils.

While a number of dietary patterns appear to support heart health, the typical Western diet is not included amongst these. In comparison to heart healthy eating patterns, most New Zealanders do not eat sufficient vegetables and fruit, wholegrains, legumes, or oily fish; and eat too much fatty or processed animal foods and refined grains.

Background

A large variety of dietary patterns exist throughout the world, some of which have been suggested to be beneficial for health, whereas others have been suggested to increase the risk of disease, including cardiovascular disease (CVD).

The Heart Foundation of New Zealand has previously published a position paper on dietary patterns (1999). Based on the epidemiological and randomised controlled trial evidence available at the time, the Heart Foundation concluded that dietary patterns associated with increasing the risk of coronary heart disease (CHD) included the traditional diet of Northern Europe and other "Western" nations, and the modern Western diet. These dietary patterns were commonly based on full fat animal and dairy foods, low to moderate fruit and vegetables, refined cereal products and sugar and processed or fried foods.

Dietary patterns associated with protection against CHD included vegetarian diets, the traditional diet of the Mediterranean coast, the traditional diets of Asia, and modified Western dietary patterns. These dietary patterns emphasised fat sources from plant oils, nuts, seeds and fish and had a high content of vegetables, fruit, legumes and whole grain foods.

Since publication of the 1999 position paper, numerous studies on the association between dietary patterns and health have been published. This paper is an update of the position paper from 1999, and provides an overview of the current evidence on dietary patterns and health, in particular on heart health. In particular, this paper will look at the types of foods that are typically included in dietary patterns that are associated with heart health, as well as the nutrient composition of heart healthy diets.

Introduction

A variety of specific dietary factors have been associated with risk of disease, including cardiovascular disease (CVD). For example, replacing saturated fatty acids with unsaturated fatty acids and reducing sodium have been associated with a reduced risk of CVD, as have other dietary factors such as dietary fibre or polyunsaturated fatty acids (from fish and plants).

Studies that investigate the effect of specific dietary components on cardiovascular health are extremely useful to identify single components of the diet that reduce or increase risk of CVD. However, an approach that only looks at specific components of the diet may ignore the fact that our diet is composed of a pattern of many different foods and nutrients which act in synergy. Therefore, it makes sense to look at the diet as a whole to identify patterns that are associated with health outcomes, and to extrapolate from these studies common features of dietary patterns that may be linked to a protective or a detrimental effect on health.

What are dietary patterns?

Dietary patterns are dietary habits that are characterised by specific foods or food groups. A dietary pattern represents a typical habitual diet.

For example, some dietary patterns are high in fruits and vegetables, wholegrain products and low-fat dairy products, whereas others can be high in refined carbohydrates, meat and meat products.

Although a variety of dietary patterns have been identified, in reality each individual's dietary habits are unique and can be more or less similar to one or more of the major dietary patterns identified.

However, studying the association between dietary patterns and health outcomes is complex and findings should be interpreted with caution, in particular when trying to look at single foods or nutrients. It is difficult from these types of studies to disentangle which components of a dietary pattern contribute to a reduced or increased risk of disease. In addition, other lifestyle factors may affect risk of disease and may not always be appropriately accounted for. The methods of identifying dietary patterns also vary between studies, making it more difficult to draw firm conclusions. Most methods measure if people more or less adhere to a certain pattern, but actual intakes of different foods and nutrients may vary significantly between individuals adhering to a certain dietary pattern.

Typical dietary patterns in New Zealand

The New Zealand Nutrition Survey provides some insights into the dietary habits of New Zealanders [University of Otago and Ministry of Health 2011]. The data does not allow conclusions to be drawn on overall dietary patterns of New Zealanders (e.g. whether those who have high intakes of fruit and vegetables also have high intakes of wholegrain products), but it gives insight into what areas of the diet may need improving and which population groups may be particularly vulnerable to an inadequate diet.

The latest survey found:

- Around two-thirds (66%) of New Zealanders ate three or more servings of vegetables (excluding vegetable juice) each day and less than two thirds (60%) reported eating two or more servings of fruit (excluding fruit juice) each day.
- A similar number chose whole-grain types of bread most often (63%).
- Almost half (48%) reported using reduced-fat or trim milk instead of whole milk.
- Red meat was the most frequently eaten meat, consumed three to four times a week by 45% of the adult population, and once or twice per week by 30%. Chicken was eaten once or twice a week by half adult New Zealanders (56%), and around a quarter (24%) reported eating chicken three to four times per week.
- Fresh or frozen seafood was reported to be eaten by 42% of New Zealand adults one or more times a week, and by 30% less than once a week, whereas 28% reported not having eaten fish in the prior four weeks. Canned seafood was eaten by 29% of the population one or more times a week, and by 29% less than once a week.
- Processed meat was eaten once or twice a week by 42% of the population, and three to four times per week by 20%.
- Fast food or takeaways were reported as being never eaten or eaten less than once a week by 66% of the population, one or two times a week by 28%, and three or more times a week by 6%.
- Soft drinks or energy drinks were reported to be consumed three or more times a week by 24% and consumed daily by 7% of the population.

Overall, findings of the NZANS 2008/09 suggested that many New Zealanders do not follow a cardio-protective dietary pattern. In particular younger adults seemed to have less favourable eating habits compared to older adults. Also, socio-economic status seems to play a role, as those from more deprived areas reported generally more unfavourable eating habits.

Evidence overview

Nature of Evidence

Where available, evidence used in this background paper was drawn from systematic reviews and meta-analysis. However, only a few reviews and meta-analyses have been published since 1999. In sections where reviews were not available, individual studies published since the 1999 position statement have been used.

The bulk of evidence on dietary patterns and associations with health comes from observational studies (mainly prospective cohort studies). This type of study does not allow conclusions to be made on the effect of certain dietary patterns on health, but solely establishes an association between the two. There is always the chance of residual confounding in observational studies, i.e. that some factors not accounted for may have been partly responsible for an observed association. In addition, diet is often only assessed at one point of time (usually at time of recruitment), which means that any changes in the diet are generally not accounted for. The methods used for assessing dietary habits also vary between studies, which may impact on study outcomes. An advantage of cohort studies is that they are generally carried out in a healthy population, which provides evidence for the role of dietary patterns in primary prevention.

The only type of study that can show a causal relationship are randomised controlled trials (RCTs). There are fewer RCTs available investigating the effect of dietary patterns on health. RCTs are generally carried out in those with already established disease or a high risk of disease. This is because the likelihood of a disease event is much higher in these vulnerable populations, which increases the chances of finding an effect in a shorter period of time and in a smaller population group. Due to the nature of the studies which have been conducted, the findings of RCTs generally provide evidence on the effect of a dietary pattern in secondary prevention rather than primary prevention.

More evidence was available for some of the dietary patterns (e.g. vegetarian and Mediterranean diet), whereas the amount of evidence was limited for other dietary patterns (e.g. Asian diet).

Mediterranean Diet

The traditional Mediterranean dietary pattern has previously been reported to be associated with a reduced risk of developing CVD (primary prevention) and a lower risk of reinfarction rates in people with already established CVD (secondary prevention) [HF position paper 1999].

The traditional Mediterranean diet is characterised by a high intake of vegetables, legumes, fruits and nuts, cereals (largely unrefined), and olive oil, and a low intake of saturated fat. A moderately high intake of fish, a low-to-

moderate intake of dairy products, a low intake of meat and poultry, and a regular but moderate intake of alcohol, primarily in the form of wine, are other characteristics of the traditional Mediterranean diet [Trichopoulou *et al.* 2003].

An example of food components of a traditional Mediterranean diet are shown in Table 1. It gives sex-specific median intakes in the Greek cohort of the EPIC (European Prospective Investigation Into Cancer) study.

Table 1: Median intake of dietary components considered in the Mediterranean diet score (by Trichopoulou et al.) in the Greek cohort of the EPIC study [Trichopoulou et al. 2009]

Dietary variable of Mediterranean diet score	Men	Women
Vegetables (g/day)	549	499
Legumes (g/day)	9.1	6.7
Fruits and nuts (g/day)	363	357
Cereals (g/day)	178	140
Fish and seafood (g/day)	24	19
Dairy products (g/day)	196	191
Meat and meat products (g/day)	121	90
MUFA:PUFA ratio	1.7	1.7

Cardiovascular Disease

A systematic review of prospective cohort studies, published in 2010, investigated the relationship between adherence to a Mediterranean diet, overall mortality and incidence of chronic diseases (including CVD) in primary prevention. Meta-analysis of data from nine cohorts (from eight studies) found that for every two-point increase in adherence score for the Mediterranean diet (of a maximum attainable score of 7-9) overall mortality risk was reduced by 8%, and risk of CVD incidence and mortality was reduced by 10%, which was statistically significant [Sofi *et al.* 2010 & 2008].

Two of the observational studies included in the review looked at the different components of the Mediterranean pattern in more detail. Martinez-Gonzales et al. [2009] found that most of the components of the Mediterranean diet were associated with CVD and CHD in the expected direction. However, this was only statistically significant for one component (fruits and nuts), which could be due to a relatively small number of CVD cases. One component that was associated with CVD and CHD in a direction that was not expected was cereals. In the studied population these were mainly consumed as white bread. Those who had the highest intake of white bread had a 92% higher risk of CHD compared to those with the lowest intake. When adjusting for energy intake, this was no longer significant, suggesting that those who consumed the most white bread also had higher energy intakes. Thus it may not be bread *per se* but rather excess energy intake from bread that may have led to an association. When cereals were excluded from the Mediterranean diet score, the inverse association between a high Mediterranean die score and CVD and CHD was stronger.

In the Spanish cohort of the EPIC study, Buckland et al. [2009] found that the association between components of the Mediterranean diet and CHD varied between men and women. [Buckland et al. 2009]. CHD risk was lower in men who had higher intakes of vegetables (>135g vs <78g per 4184kJ), higher intakes of fish (>31g vs <17g per 4184kJ) and lower intakes of dairy (<95g vs >170g per 4184kJ). There was no statistically significant association in women. In women, a higher intake of olive oil was associated with a significantly lower risk of CHD, and a higher meat intake was associated with a significantly higher risk. However, neither were associated with risk in men. Gender differences could possibly be due to differences in average intakes between men and women, and possibly different results would be found if sex-specific cut-offs were used. Of note, the occurrence of CHD in this cohort was significantly higher in men than it was in women, which may have also influenced these findings.

Some studies investigated whether confounding from factors such as energy intake, physical activity, smoking, BMI, family history of CVD or risk factors, accounted for some of the association between the Mediterranean diet and reduced risk of CVD. In two US based studies, after adjusting for these and other potential confounding factors (e.g. race, education level) the effect size was clearly lower than when only adjusting for age (and energy in one study) [Fung et al. 2009; Mitrou et al. 2007]. This means that in these two study populations the confounding factors explained some of the lower risk observed in people more closely adhering to a Mediterranean diet. However, in two Mediterranean cohorts (one Greek, one Spanish) adjustment for potential confounding factors did not markedly change the effect size, suggesting that a protective effect on CVD risk is likely to be largely due to better adherence to the Mediterranean diet [Trichopoulou et al. 2003; Martinez-Gonzales et al. 2009].

The Lyon Diet Heart Study is an RCT that investigated the effect of the Mediterranean diet in a group of men and women aged <70 years who survived a myocardial infarction (MI) (secondary prevention). The authors of the study found a significant reduction in major coronary events in the group following a Mediterranean-style diet, compared to the control group, who only received generic dietary counselling. The intervention was for 27 months, with a further 19 months of follow-up. After 46 months the combined risk of cardiac death and recurrent MI was reduced by 82% [de Lorgeril *et al.* 1999]. However, several methodological issues have been highlighted such as early termination of the study, possibly leading to an overestimation of risk reduction, baseline diet only being assessed in the experimental but not the control group, and dietary data only being reported for 227 out of 605 study participants. Therefore, findings need to be interpreted with caution [McKeown *et al.* 2010].

Findings from a more recent RCT, the PREDIMED (Prevención con Dieta Mediterránea) study, also suggest that the Mediterranean diet is associated

with lower risk of CVD. In this study Spanish men and women aged 55-80 years who were at high risk of developing CVD followed a Mediterranean diet, either supplemented with extra-virgin olive oil or with mixed nuts, or a control diet (advice to reduce fat). Participants in both Mediterranean diet groups had a significantly reduced risk (about 30%) of developing CVD compared to those in the control group. Further analysis only showed a statistically significant reduced risk of stroke, but not of MI or death from cardiovascular causes. The authors suggested this may have been due to insufficient statistical power [Estruch *et al.* 2013]. It is worth noting that although there were differences in type of fat consumed, overall fat intakes between the groups were similar. According to the authors the main dietary differences involved the supplemental items (olive oil and nuts). This is likely to be because of the study location (Spain) where the baseline diet is likely to be a Mediterranean diet.

Metabolic syndrome and components

A group of researchers from Greece and Italy systematically reviewed the evidence of the effect of the Mediterranean diet on metabolic syndrome and its components [Kastorini *et al.* 2011]. The review authors included both observational studies and clinical trials (which were all short term trials). Based on data from clinical trials, a significant protective combined effect of the Mediterranean diet was found for all examined components of metabolic disease, including waist circumference (-0.4cm), HDL cholesterol (+1.2mg/dl), triglycerides (-6.1mg/dl), systolic and diastolic blood pressure (-2.4 and -1.6mm Hg), blood glucose levels (-3.9mg/dl) and insulin resistance (-0.5 HOMA-IR).

The proportion of mono-unsaturated fatty acids in most clinical trials was relatively high and was mostly above 20% of total energy [Kastorini et al. 2011]. This is in line with intakes observed in a Greek cohort, where intakes of mono-unsaturated fatty acids in those who adhered to a Mediterranean diet was 25-28% of energy. However, two observational studies in Spanish cohorts found mono-unsaturated fatty acid intakes of around 15% of total energy in those adhering to a Mediterranean diet [Martinez-Gonzales et al. 2009; Buckland et al. 2009].

The contribution of fat to total energy intake was also relatively high in many of the intervention studies (35-40%), whereas the contribution of carbohydrates to total energy intake was around 45-50% [Kastorini et al 2011].

Meta-analysis of data from cross-sectional studies resulted in similar findings but to a greater level than clinical trials [Kastorini *et al.* 2011]. However, they are a weaker study design.

More detailed analysis of data from clinical trials showed that a significant protective effect was only evident in studies carried out in Mediterranean countries, in studies with more than 65 participants, and studies with a duration of at least three months [Kastorini *et al.* 2011]. More significant

findings were evident in studies that promoted physical activity, and that were of high compared to low study quality [Kastorini *et al.* 2011]. The study authors emphasised that there was significant heterogeneity between the different studies included in the review, which limits generalisation of its findings.

A systematic review and meta-analysis of RCTs (n=6) investigated the effect of the Mediterranean diet on markers of the metabolic syndrome compared to low-fat diets. Studies were included if they had a minimum follow-up of six months and reported intention-to-treat data [Nordmann *et al.* 2011]. Five of the six studies were in primary prevention. There was a significant positive effect of the Mediterranean diet compared to low-fat diets at two years follow-up for weight loss (-2.2kg), change in BMI (-0.6kg/m^2), change in waist circumference (-0.9cm), change in systolic and diastolic blood pressure (-1.7 and -1.5mm Hg), change in total cholesterol (-7.4mg/dl), and change in fasting plasma glucose (-3.8mg/dl). A non-significant positive effect was found for LDL cholesterol (-3.3mg/dl) and HDL cholesterol (+0.9mg/dl) [Nordmann *et al.* 2011].

Recommended total fat (<30-35% of energy) and mono-unsaturated fatty acid intakes (10-25% of energy) were generally lower than in studies included by Kastorini (which also were much shorter in duration), and mostly conformed to levels recommended for New Zealand adults. The Mediterranean diet groups were advised to eat more fruits, vegetables, nuts, fish, olive oil, and wholegrain, and reduce intake of red and processed meat.

Evidence from prospective cohort studies is limited. The Framingham Offspring Cohort study, carried out in a US population, found that better adherence to the Mediterranean diet was associated with lower insulin resistance, waist circumference, fasting plasma glucose and triglycerides, and higher HDL cholesterol in participants free of diabetes at baseline after seven years of follow-up. No significant association with blood pressure was found. The authors did not report baseline levels of these metabolic syndrome components, or the change in levels over the seven years follow-up, which limits interpretation of the data (i.e. differences may already have existed at baseline). Participants free of metabolic syndrome or diabetes at baseline and who were in the highest quintile of adherence to the Mediterranean diet had a statistically significant lower incidence rate of metabolic syndrome compared to those in the lowest quintile (30.1% vs. 38.5%) [Rumawas et al 2009].

Qualitative aspects of the traditional Mediterranean diet in included studies

The Mediterranean diet is typically high in foods considered beneficial for health, and contains moderate to low amounts of foods that are considered less beneficial for health (see Table 2). This generally leads to a more beneficial nutrient intake in those with higher Mediterranean diet scores (see Table 3). For example, Martinez-Gonzales [2009] found that a high compared to a low Mediterranean diet score was associated with a significantly lower intake of fat (33% vs 40% of energy intake) and saturated fat (10% vs. 15%), and

a significantly higher olive oil consumption (29g vs. 14g/day) and fibre intake (40g vs. 18g/day). Also in other studies it was found that those who adhered more closely to the Mediterranean diet generally had higher intakes of dietary fibre and carbohydrates, and lower intakes of saturated fatty acids and total fat, or a higher monounsaturated to saturated fatty acid ratio [Buckland et al. 2009; Fung et al. 2009; Mitrou et al. 2007]. Intakes of monounsaturated fatty acids were not consistently reported to be higher or lower in those with high Mediterranean diet scores, despite higher intakes of olive oil found in studies carried out in Mediterranean countries [Buckland et al. 2009; Martinez-Gonzalez et al. 2009].

Table 2: Recommendations for Mediterranean diet in the PREDIMED study, and intake frequency of foods in the Nurses' Health Study cohort

Foods	Recommended servings per day or week (PREDIMED study)[1]	Servings/day consumed by high- vs. low-scorers (Nurses' Health Study)[2]	
		Low	High
Meat	White instead of red		
Red and processed meat	<1/day	1.0/day	0.8/day
Fish, seafood	≥3/week (esp. fatty)	0.2/day	0.5/day
Whole grains		0.4/day	1.6/day
Vegetables	≥2/day	1.8/day	4.4/day
Potatoes			
Fruit	≥3/day	1.3/day	3.2/day
Pulses/legumes	≥3/week	0.2/day	0.6/day
Olive oil	≥4/day (tablespoons)	-	-
Nuts/seeds	≥3/week	0.1/day	0.5/day
Sugar-sweetened beverages	<1 drink/day	-	-
Commercial bakery goods, sweets, and pastries	<3/week	-	-
Wine with meals	≥7 glasses/week (optional, only for habitual drinkers)	-	-

[1]Estruch et al. 2013; [2]Fung et al. 2009

Table 3: Dietary composition of diets in study participants with low and high scores of Mediterranean diet score; epidemiological studies.

	Low scores			High scores		
	ATTICA study[1]		EPIC[2] and SUN study[3]	ATTICA study[1]		EPIC[2] and SUN study[3]
	Men	Women	Men and women combined	Men	Women	Men and women combined
% of Energy						
Total fat	47	48	38-40	39	40	33-35
SFA	15	15	13-15	12	11	10
MUFA	24	24	15-16	25	28	15-16
MUFA:SFA (ratio)	1.8	1.8	1.1	2.5	2.2	1.6
PUFA			6			5
Protein			18			18
Carbohydrates			40			47
Fibre			18-20			27-40

[1]Pangiotakos et al. 2006; [2]Buckland et al. 2009; [3]Martinez-Gonzales et al. 2009; SFA saturated fatty acids; MUFA monounsaturated fatty acids; PUFA polyunsaturated fatty acids;

SUMMARY: TRADITIONAL MEDITERRANEAN DIET

- Increased adherence to the Mediterranean diet seems to decrease the risk of CVD in primary and in secondary prevention.
- Whereas lifestyle factors including physical activity and smoking, as well as BMI, seem to explain some of the protective effect in US cohorts, this is not the case in Mediterranean cohorts. It is likely that those who adhere more closely to the Mediterranean diet but live in countries outside the Mediterranean region are more health conscious overall.
- There is also some evidence that the Mediterranean diet reduces the risk of developing metabolic syndrome and has a protective effect on most components of the metabolic syndrome.

Vegetarian Diet

Vegetarian diets do not contain meat, poultry or fish; vegan diets further exclude dairy products and eggs [Key *et al.* 2006]. A vegetarian diet has long been associated with lower blood lipid levels, reduced risk of CHD, reduced blood pressure and lower body weight compared to non-vegetarian diets [see HF position paper 1999]. However, vegetarian diets are defined by what they do not contain and the actual composition of the diet can vary widely [Key *et al.* 2006]. On average though, people who follow a vegetarian diet generally have higher intakes of plant foods including fruits, vegetables, legumes and nuts, which have been associated with a protective effect on health [Hu 2006]. Data from the EPIC-Oxford study also shows that in general vegetarians and vegans seem to eat a diet with a more favourable nutrient composition than meat eaters [Appleby et al. 2002]. In addition, people who follow a vegetarian diet tend to have a healthier lifestyle altogether, including more physical activity, less smoking and lower alcohol consumption [Chang-Claude et al. 2005].

Cardiovascular Disease

A collaborative analysis (published 1999) of findings from five prospective studies found that vegetarians (defined as not eating any meat or fish) had a significantly lower IHD mortality risk (by 24%), whereas risk of dying from cerebrovascular disease and risk of all-cause mortality were similar to non-vegetarians [Key *et al.* 1999]. The lower mortality from IHD was observed in people with and without history of CVD or diabetes at time of recruitment.

The review authors also found that IHD mortality risk was significantly lower in occasional meat eaters (by 20%), fish eaters (by 34%) and vegetarians (excluding vegans, by 34%) compared to regular meat eaters. IHD risk in vegans was 26% lower compared to regular meat eaters, but this was not statistically significant (although this could have been due to the relatively low number of vegans in the included studies). A lower risk of all-cause mortality was also found in occasional meat eaters, fish eaters and vegetarians compared to regular meat eaters, but not in vegans [Key *et al.* 1999]. Risk of cerebrovascular mortality was not significantly different between the different groups [Key *et al.* 1999].

The findings by Key *et al.* [1999] suggest that a reduced meat intake rather than avoidance of meat altogether is associated with a lower risk of IHD and total mortality. Those who eat less meat may have an overall healthier dietary pattern and may lead a healthier lifestyle compared to regular meat eaters, and the findings are therefore likely to be a reflection of an overall healthier dietary pattern and lifestyle.

A more recent systematic review and meta-analysis, published in 2012, also reviewed the evidence of vegetarian diets in association with CVD and overall mortality from prospective studies [Huang *et al.* 2012]. In contrast to the

analysis by Key *et al.* [1999], the authors of this review defined vegetarians as those who did not eat meat or fish (including lacto-ovo vegetarians and vegans) or ate these foods less than once a week. Based on findings from seven prospective cohort studies, risk of all-cause mortality was not significantly different between vegetarians (including those eating very little meat and fish) and non-vegetarians, whereas IHD mortality risk was significantly lower in vegetarians (by 29%; including those eating very little meat and fish) compared to non-vegetarians. Risk of cerebrovascular disease mortality was somewhat lower in vegetarians (including those eating very little meat and fish), but this was not statistically significant [Huang *et al* 2012].

The latest results of the EPIC (European Prospective Investigation into Cancer and Nutrition)-Oxford cohort also confirmed a protective association of a vegetarian diet with IHD mortality risk, even when results were adjusted for BMI [Crowe *et al.* 2013]. The meat-eaters in the EPIC-cohort are not reflective of the average UK population but are generally a more health conscious population group [Key et al. 2009], which means that it is likely that the protective association can be explained by dietary factors, rather than confounded by lifestyle.

Both Huang *et al* [2012] and Key *et al* [1999] hypothesised that the lower mortality rate from IHD can at least partly be explained by lower cholesterol levels in people eating a vegetarian diet.

Blood lipids

Vegetarian diets have long been associated with reduced blood lipid levels [see Bremer et al. 1999; Key *et al.* 1999 & 2006, Craig *et al.* 2009]. In a review including 10 cross-sectional studies, nine demonstrated significant differences between the cholesterol levels of subjects eating plant-based diets and those of the general population. Those studies that reported on nutrient intakes of the study population found that in studies that evaluated the effects of different types of plant-based diets, populations following vegan diets had the lowest cholesterol concentrations. Of the three case-control studies identified, two demonstrated significantly lower total cholesterol and LDL cholesterol values in the populations consuming plant-based diets, whereas one case-control study found no significant difference [Ferdowsian & Barnard 2009].

Cross-sectional analysis within the EPIC-Oxford cohort (not included in the review) also revealed significantly lower total and LDL cholesterol levels in vegetarians and vegans, more so in the latter group [Thomas *et al.* 1999].

Evidence from RCTs also suggests that vegetarian and vegan diets have a more beneficial effect on total cholesterol and LDL cholesterol compared to control diets. Ferdowsian and Barnard [2009] concluded that, while it is difficult to compare the effects of dietary interventions from various studies, the reviewed studies suggest that a greater reduction in dietary animal products yields greater reductions in lipid levels. The review authors

suggested that primary plant-based (i.e. allowing small amounts of lean meat) and lacto-ovo-vegetarian dietary interventions were associated with decreases of total cholesterol and LDL cholesterol of about 10% to 15%, vegan dietary interventions were associated with decreases of approximately 15% to 20%, and combination dietary interventions (vegetarian diets with additional fibre, soy and nuts) were associated with decreases of approximately 20% to 35% [Ferdowsian & Barnard 2009].

Both data from observational studies and RCTs suggests that a vegetarian diet is also associated with lower HDL cholesterol compared to non-vegetarians. However, it has been suggested that evidence from observational studies does not support an association of decreased HDL cholesterol with poor cardiovascular health in vegetarians [Ferdowsian & Barnard 2009]. Total to HDL cholesterol ratios were not reported, but seeing that total cholesterol levels were clearly more affected by a vegetarian diet than HDL cholesterol, it can be assumed that the ratio would have declined.

Observational studies show that long-term adherence to a vegetarian diet is consistently associated with lower plasma triglyceride concentrations. However, RCTs have demonstrated varied effects on triglycerides [Ferdowsian & Barnard 2009]. Thus the effect on triglycerides is inconclusive.

A subsequent RCT in patients with type 2 diabetes found that both a low-fat vegan diet and a diet following the 2003 *American Diabetes Association* guidelines were effective in lowering total and LDL cholesterol levels. When controlling for medication changes (i.e. using the last value before any medication adjustment) the low-fat vegan diet was significantly more effective in lowering total and LDL cholesterol levels. Following the low-fat vegan diet led to significantly lower intakes of saturated and monounsaturated fat, but not polyunsaturated fat (as a proportion of total energy), and significantly higher intakes of carbohydrates (as a proportion of total energy) and fibre (see Table 4) [Barnard *et al.* 2009a].

Table 4: Nutrient intakes in subjects from a RCT either following a vegan diet or following a diet based on the 2003 *American Diabetes Association* guidelines (control group) [Barnard et al. 2009a)

	Vegan group	Control group
% of Energy		
Total fat	22.3	33.7
SFA	5.1	9.9
MUFA	8.2	13.1
PUFA	7.0	7.7
Protein	14.8	21.1
Carbohydrates	66.3	46.5
Fibre (g/day)	21.7	13.4

SFA saturated fatty acids; MUFA monounsaturated fatty acids; PUFA polyunsaturated fatty acids

Another RCT in patients with type 2 diabetes comparing a vegetarian diet with an iso-caloric conventional diet for diabetics (based on recommendations by

the European Association for the Study of Diabetes) found a significantly reduced LDL cholesterol concentration in the vegetarian group after 12 and 24 weeks, whereas no significant effect was found in the conventional diet group. Neither diet had a significant effect on total cholesterol levels. In this study, following a vegetarian diet led to significant increases in intakes of fibre, and significant decreases in intakes of protein and cholesterol, as well as a significant increase in polyunsaturated to saturated fatty acid ratio of the diet, compared to those following a conventional diet for diabetics [Kahleova *et al.* 2011].

Blood pressure

It has previously been reported that vegetarian diets are associated with reduced blood pressure [see Bremer et al. 1999]. A review published in 2005 also reported that observational studies consistently found lower blood pressure levels in vegetarians compared to non-vegetarians. In most studies included in the review, some of the variation was explained by a lower BMI in vegetarians, but not all studies have found this. The review authors concluded that observational studies show that the systolic blood pressure of vegetarians is 3 to 14mmHg lower and the diastolic blood pressure 5 to 6mmHg lower than that of non-vegetarians. The prevalence of hypertension ranged from 2% to 40% in vegetarians compared to 8% and 60% in non-vegetarians [Berkow & Barnard 2005]. Data from a small number of RCTs also suggests that switching from an omnivorous to a vegetarian diet reduces blood pressure in normotensive and hypertensive subjects. In these studies a low sodium intake appeared not to be associated with the blood pressure-lowering effect [Berkow & Barnard 2005].

Analysis within a sub-sample of subjects from the EPIC-Oxford cohort with no self-reported hypertension, resulted in small but statistically significant differences in age-adjusted blood pressure levels in different dietary groups (meat eaters, fish eaters, vegetarians, vegans). Meat eaters on average had the highest, and vegans the lowest, blood pressure [Appleby *et al.* 2002]. When adjusting for BMI, the difference between the groups was no longer significant (except for diastolic blood pressure in women). Further adjustment for non-dietary factors (physical activity, hormone exposure in women), macronutrients and micronutrients highlighted that these factors, together with age and BMI, accounted for two-thirds to three-quarters of the variation in blood pressure [Appleby *et al.* 2002]. Participants with self-reported hypertension were excluded, and their inclusion in the analysis could alter findings.

Findings from the Adventist Health Study-2 also showed a significant difference in blood pressure levels between non-vegetarians and vegetarians, with lower levels found in vegetarians. Vegans and vegetarians had lower odds of hypertension, however, when adjusting for BMI these were

substantially diminished and no longer statistically significant [Pettersen *et al.* 2012].

Overall, evidence suggests that those following a vegetarian or vegan diet seem to have lower blood pressure levels than meat eaters. Much of this protective effect of a vegetarian diet on blood pressure seems to be explained by the lower body weight of vegetarians and vegans, and other dietary and non-dietary factors, although more research will be needed to see to what extent these factors impact on blood pressure. Salt intake is one of the main dietary determinants of blood pressure [SACN 2003]; however, salt intake may not be sufficiently accounted for in observational studies.

Diabetes

A review published in 2009 investigated the relationship between a vegetarian diet and type 2 diabetes [Barnard *et al.* 2009b]. Data from observational studies suggested that diabetes prevalence was lower among vegetarians compared with omnivores. In a prospective study of Adventists, long-term adherence (more than 17 years) to a vegetarian diet was associated with a 74% reduced risk of developing diabetes relative to long-term adherence to a diet that included at least weekly meat intake [Vang *et al.* 2008].

A subsequent prospective cohort study (Adventist Health Study-2) also found that after two years of follow up the lowest odds for developing diabetes was in vegans, followed by semi- or other forms of vegetarians. Adjusting for BMI weakened the odds, but most remained statistically significant [Tonstad *et al.* 2011].

Several intervention trials have also found that eating a plant-based diet (either vegetarian or near-vegetarian) leads to improvements in insulin sensitivity and glycaemic control, and a reduced use of insulin use in type 2 diabetes sufferers [Barnard *et al.* 2009b]. The review authors suggested that weight loss accounts for much, although not all, of the effect of plant-based diets on glycaemic control.

Qualitative aspects of vegetarian diets in studies included

As mentioned above, a vegetarian diet is defined by what is not included and the actual composition and quality can vary widely. Only a few observational studies looking at vegetarian diets and heart disease provide detailed information about food and nutrient intakes of the studied population groups. This makes it difficult to identify what factors may be responsible for the observed lower health risk in those who eat very little meat or avoid it completely based on these studies.

It has previously been reported that total fat intakes in vegetarians can vary widely from 15-40% of energy and intakes in lacto-vegetarians may or may not

differ from intakes of moderate meat-eaters [Bremer et al. 1999]. Vegans generally have the lowest fat intakes. Saturated fat intakes as a proportion of energy are generally lower in vegetarians, and always lower in vegans. Vegetarian intakes of whole grains, carbohydrates and dietary fibre are generally higher, and intakes of cholesterol lower in vegetarians compared to meat-eaters. Also the proportion of polyunsaturated to saturated fatty acids is generally higher in vegetarian diets [Bremer et al. 1999].

In a large UK-based population study (EPIC-Oxford) with 11,000 participants, meat eaters only had slightly higher intakes of fat and saturated fat than fish eaters or vegetarians, whereas the difference to vegans was more pronounced, in particular for saturated fat (see Table 5). It has to be noted that the average intake of saturated fat in meat eaters of this study population is clearly below the UK average of almost 13% of energy [Bates et al. 2011], which reflects that the meat eaters in the study were not a representative sample of the UK population but were on average more health conscious [Key et al. 2009]. The ratio of polyunsaturated to saturated fat was somewhat higher in fish eaters and vegetarians compared to meat eaters, and was clearly higher in vegans. Fibre intake was higher in fish eaters and vegetarians compared to meat eaters, and was even higher in vegans [Appleby et al. 2002].

Table 5: Average nutrient intakes of meat eaters, fish eaters, vegetarians and vegans in the EPIC-Oxford study cohort [Appleby et al. 2002]

	Men				Women			
	Meat eaters	Fish eaters	Vegetarians	Vegans	Meat eaters	Fish eaters	Vegetarians	Vegans
% of Energy								
Energy KJ	9119	9077	8909	8058	8005	7897	7705	7123
Total fat	31.5	31.1	30.9	28.7	31.1	30.6	30.4	28.7
SFA	10.4	9.1	9.1	4.9	10.0	9.2	9.2	5.2
PUFA	5.2	5.9	5.8	7.8	5.2	5.6	5.4	7.6
PUFA/SFA ratio	0.56	0.72	0.71	1.65	0.57	0.67	0.66	1.53
Protein	16.1	14.1	13.1	12.8	17.4	14.9	13.9	13.4
Carbohydrates	47.6	50.7	51.7	54.7	49.0	51.5	53.0	55.5
Fibre[1] (g/day)	19.9	24.0	24.0	28.2	20.2	22.7	22.9	26.5

[1]Non-starch polysaccharides; SFA saturated fatty acids; PUFA polyunsaturated fatty acids;

In terms of food intake, the EPIC Oxford study reported some differences between the vegetarian and non-vegetarian cohort, other than consumption of meat and fish (see Table 6). The vegetarian cohort consumed less milk and more whole grain than the non-vegetarian study population. Intakes of vegetables were only somewhat higher in vegetarian compared to non-vegetarian women, and were higher in vegetarian compared to non-vegetarian men. However, there was no difference in consumption of fresh fruit, and peanuts or other nuts between vegetarian and non-vegetarian women. The difference in fruit consumption between vegetarian and non-vegetarian men was small, but vegetarian men consumed twice the amount of peanuts and other nuts. Other foods that may explain some of the heart health

benefits of vegetarian diets were not reported (e.g. legumes, soya), and neither was nutrient intake [Crowe et al. 2013].

In the Giessen Wholesome Nutrition Study the differences in food intake between vegetarians and non-vegetarians were more pronounced. Those following a lacto-ovo vegetarian diet consumed more whole grain products, vegetables and legumes, fruit, edible fat and cooking oil, and less bread and pastries made from refined flour, milk and dairy products and eggs, compared to those following an average German diet [Hoffmann et al. 2001].

Table 6: Differences in food consumption (g/day) between vegetarians and non-vegetarians

	EPIC-Oxford cohort[1]				Giessen Wholesome Nutrition Study[2]	
Foods (g/day)	Men		Women			
	Non-vegetarians	Vegetarians	Non-vegetarians	Vegetarians	Meat eaters	Ovo-lacto vegetarians
Meat	64	0	49	0	70	0
Meat products					50	0
Fish	33	0	34	0	21	0
Dairy products					223	163
Dairy milk (mL/d)	293	149	293	149		
Dairy cheese	15	19	19	23		
Eggs					16	6
Whole grains	43	99	49	80	47	159
Refined grains					136	9
Vegetables	206	246	243	267	203[3]	405[3]
Fruit	179	197	238	239	190	373
Nuts/seeds	2.1	4.2	2.1	2.1		
Desserts, sweets					33	9

1Crowe et al. 2013; [2]Hoffmann et al. 2001; [3]Including legumes;

Overall, vegetarians tend to have higher intakes of foods and nutrients that have been associated with lower risk of heart disease and more beneficial effects on cardiovascular risk factors, and lower intakes of foods and nutrients that have been found to be less beneficial for health.

SUMMARY: VEGETARIAN DIET

- A vegetarian diet is associated with lower IHD mortality risk (more so in vegans), but does not seem to be associated with cerebrovascular mortality.
- Vegetarians, and in particular vegans, generally have lower total and LDL cholesterol levels than non-vegetarians. Observational studies suggest vegetarians have lower triglyceride levels, but evidence from RCTs is inconclusive.
- Blood pressure levels are lower in vegetarians (more so in vegans) compared to non-vegetarians; however, much of this effect can be explained by the lower BMIs of vegetarians, and in particular of vegans.
- People eating a vegetarian diet seem to have a lower risk of developing type 2 diabetes. A vegetarian diet also seems to be effective in the treatment of type 2 diabetes.
- Vegetarians and vegans are generally more health conscious overall, which would explain some of the protective effect of these types of diet.

DASH Diet

The DASH diet, short for Dietary Approaches to Stop Hypertension, is an eating plan that has specifically been developed to lower blood pressure levels [U.S. Department of Health and Human Services 2006]. The DASH diet provides a detailed diet plan which is low in saturated fat, cholesterol and total fat, and emphasises fruits, vegetables, and fat-free or low-fat milk and milk products. It also includes whole grain products, fish, poultry, and nuts. It focuses on increasing intake of foods rich in nutrients that have been suggested to lower blood pressure, including potassium, calcium, magnesium, protein and fibre [U.S. Department of Health and Human Services 2006].

Cardiovascular disease

A small number of prospective studies have investigated the association between adherence to the DASH diet and risk of CVD, some of which have found that adherence to a DASH-style diet was associated with a lower risk of CVD [Fung *et al.* 2008; Levitan *et al.* 2009a+b], whereas others found no association [Folsom *et al.* 2007; Fitzgerald *et al.* 2012].

Two scoring systems have been developed to assess adherence to the DASH diet. Fung *et al.* [2008] scored adherence based on eight components of the DASH diet: high intake of fruits, vegetables, nuts and legumes, low-fat dairy products, and whole grains, and low intake of sodium, sweetened beverages,

and red and processed meats. Scores were given based on quintiles of intake. It measures closer level of adherence to a DASH diet rather than actual adherence, and therefore does not allow conclusions to be drawn on whether a DASH style diet is or is not associated with a lower risk of CVD.

Folsom *et al.* (2007) developed a far more stringent diet score to assess adherence to the DASH diet. Rather than ranking by quintile as Fung did, they used quantitative criteria to establish cut-off points. For example, a full point was assigned to those consuming four or more servings of vegetables daily, 0.5 points for those approaching the recommended level (2-3 servings per day), and no points given to those consuming far less than the recommended level.

When Fung *et al.* applied their score within the Nurses' Health Study cohort, a significantly reduced risk of total CHD (24%), non-fatal CHD (22%) and fatal CHD (29%) was found in the highest quintile of cumulative DASH score compared to those in the lowest, after adjustment for several other risk factors including smoking, BMI, energy intake and physical activity. This association was more pronounced when only adjusting for age and energy intake, in normal weight subjects (BMI<25), in smokers, in those with a history of hypertension and in those with lower physical activity levels [Fung *et al.* 2008].

The score by Fung *et al.* [2008] was also applied to the Women's Health Study cohort. In this prospective study, no association between adherence to a DASH-style diet and risk of CHD or venous blood clots was found [Fitzgerald *et al.* 2012].

Researchers from Sweden applied the score developed by Fung *et al.* [2008] to a female cohort (Swedish Mammography Cohort) and a male cohort (Cohort of Swedish Men). There was a significant inverse association between better adherence to a DASH-style diet and risk of heart failure [Levitan *et al.* 2009a+b]. Females in the highest quartile of DASH scores had a 37% lower risk of heart failure, and males had a 22% lower risk, compared to those in the lowest quartile, after adjusting for several potential confounding factors including physical activity, energy intake, BMI and smoking. When adjusting for age only, the association was only slightly more pronounced, suggesting that the potential confounding factors did not play a major role in the inverse association between DASH score and risk of heart failure [Levitan *et al.* 2009a+b]. When analysing the data of the female cohort with the more stringent scoring system developed by Folsom *et al*, no association was found. The study authors suggested this could be due to the nature of data from food frequency questionnaires, as these usually are designed to rank food intakes rather than measure absolute food and nutrient intakes [Levitan *et al.* 2009a].

Folsom *et al.* [2007] applied their scoring system within the Iowa Women's Health Study, where not a single subject complied with all 11 DASH diet goals included in the scoring index. Adherence to a DASH-style diet based on this

stringent scoring index and after adjusting for several other factors was not associated with risk of incident hypertension, CHD death, stroke death or all CVD death [Folsom *et al.* 2007].

Blood pressure

The DASH (Dietary Approaches to Stop Hypertension)-trial was the first to investigate the effect of a dietary intervention with the DASH diet[1] in American adults with systolic blood pressure levels of no more than 160mmHg and diastolic blood pressure levels between 80-95mmHg. Around two-thirds of the study population were of an ethnic minority (mainly African-American) and about one third was non-Hispanic White.

Participants consumed one of three diets over a course of eight weeks: either the DASH diet, a diet high in fruits and vegetables (also providing fewer snacks and sweets but otherwise similar to control diet), or a control diet which was in line with the average American diet. There was no difference in sodium intake between the different dietary groups; and energy content of the diets was adjusted according to participants needs. The DASH and fruit-and-vegetable diets included more fruits, vegetables, nuts, seeds and legumes than the control diet. The DASH diet contained significantly more low-dairy products, and less beef, pork and lamb, and fat, oils and salad dressings compared to both other diets. It was also lower in total, saturated and monounsaturated fat, and higher in carbohydrates and calcium than both other diets, and provided more potassium and magnesium than the control diet, but not the fruit-and-vegetable diet.

The DASH diet was the most effective in reducing blood pressure, with the difference in reduction between the DASH and the control diet being -5.5mmHg for systolic blood pressure and -3.0mmHg for diastolic blood pressure. The changes were more pronounced in hypertensive (-11.4mmHg for systolic and -5.5mmHg for diastolic blood pressure) than non-hypertensive subjects (-3.5mmHg and -2.1mmHg), and was more pronounced in ethnic minority subjects (-6.8mmHg and -3.5mmHg) than in non-minority subjects (-3.0mmHg and -2.0mmHg), but were statistically significant in all groups. Although effects on blood pressure were also observed in those following the fruit-and-vegetable diet, the DASH diet was significantly more effective in reducing blood pressure. Although some effect on blood pressure was observed when more fruits and vegetables were included, making more changes to the overall diet led to an even larger effect, emphasising that

---

[1] *The DASH diet was developed by this group of researchers and was at the time of the study called a 'combination diet'. The dietary pattern was later called the DASH diet.*

solely adjusting one aspect of the diet may not lead to a maximum benefit [Appel *et al.* 1997].

In another trial (DASH Sodium trial) the DASH and control diets were consumed with varying levels of sodium [high (3.3g sodium/day), medium (2.3g/day) and low (1.5g/day)]. As expected, reduction of sodium intake significantly lowered systolic and diastolic blood pressure. However, blood pressure reduction was significantly bigger in the DASH diet group at all sodium intake levels compared to the control diet (except for diastolic blood pressure with the lowest sodium level) [Sacks *et al.* 2001]. This suggests that a dietary intervention combining DASH diet with sodium reduction is more effective than the DASH diet alone, or an average American diet with sodium reduction.

Combining the DASH diet with a weight loss programme that involved regular physical activity was also more effective in reducing blood pressure than the DASH diet alone [Blumenthal *et al.* 2010a]. A small trial in adolescents with clinical diagnosis of prehypertension or hypertension also found that DASH intervention proved more effective than routine outpatient hospital-based nutrition care [Couch *et al.* 2008].

A small number of observational studies have also investigated whether adherence to a DASH-style diet is associated with blood pressure and/or risk of hypertension. Researchers from the Nurses' Health Study found that women adhering more closely to the DASH diet, as measured using the score developed by Fung *et al.* [2008], were less likely to develop hypertension during a mean follow-up of 14 years. Those in the highest quintile of DASH score were 18% less likely to have developed hypertension. Those who were in the highest quintile of DASH score, and also had a normal body weight and exercised daily were even less likely (54%) to develop hypertension [Forman *et al.* 2009].

In the SEARCH for Diabetes in Youth Study, young people with type 1 diabetes who closely adhered to a DASH-style diet had significantly lower odds (by 43%) of hypertension compared to those who did not adhere to a DASH-style diet. No association between DASH score and hypertension was found in young people with type 2 diabetes [Günther *et al.* 2009]. The Iowa Women's Health Study, which used the more strict approach to assess adherence to the DASH diet, did not find that the DASH diet was associated with a lower risk of developing hypertension [Folsom *et al.* 2007].

Three observational studies investigated the association of selected components (fruits, vegetables, and milk and milk products) of the DASH diet with blood pressure [Schulze *et al.* 2003; Dauchet *et al.* 2007; Moore *et al.* 2012]. Two showed a positive association, although this effect was lost in adolescent girls once results were adjusted for BMI. The third found no association in adult women.

Blood lipids

Several RCTs have investigated the effect of a DASH-style diet on blood lipids. In the original DASH trial, relative to control diet, intervention with the DASH diet resulted in significantly larger reduction of total cholesterol (net reduction -0.35mmol/L), LDL cholesterol (-0.28mmol/L), but also of HDL cholesterol (-0.09mmol/L). There was no significant effect on triglycerides or total to HDL cholesterol ratio [Obarzanek *et al.* 2001]. In the DASH-Sodium trial, the DASH diet also had a significantly greater effect on total cholesterol, LDL and HDL cholesterol than the control diet, similar to that in the original DASH-trial although slightly larger, whereas triglyceride levels and total to HDL cholesterol ratios were not significantly affected [Harsha *et al.* 2004].

In the ENCORE (Exercise and Nutritional Interventions for Cardiovascular Health) study in overweight or obese subjects with high blood pressure no effect of the DASH diet alone on blood lipids was found compared to the control diet; a significant effect was only found for the DASH diet when it was combined with weight management (weekly counselling and supervised exercise sessions 3 times a week). As in the DASH trials, study subjects following the DASH diet consumed significantly more vegetables, fruits and dairy products compared to the control diet. They also consumed a higher proportion of energy as carbohydrates, and a lower proportion as total fat and saturated fat, and had higher intakes of fibre, calcium, potassium and magnesium, and lower intakes of sodium [Blumenthal *et al.* 2010b].

Diabetes and glucose metabolism

In the ENCORE study, the DASH diet alone did not have any significant effects on glucose metabolism or insulin sensitivity compared to the control diet. Only when the DASH diet was combined with weight management was there a greater improvement in glucose response compared to the control diet [Blumenthal *et al.* 2010b]. One prospective cohort study, the multi-ethnic Insulin Resistance Atherosclerosis Study, found that adherence to the DASH diet was not associated with a lower risk of diabetes after controlling for a variety of other risk factors. However, sub-group analysis showed that Whites with greatest adherence to a DASH-style diet were significantly less likely to develop diabetes (by 75%), whereas no association was found in African-American and Hispanics (combined) [Liese *et al.* 2009].

Qualitative aspects of the DASH diet as recommended and in included studies

Tables 7 and 8 outline the goals of the DASH diet. However, most prospective studies included here measured adherence to the DASH diet based on quintiles of intakes within a population group, which means that the DASH goals were not necessarily met, even by those who scored highest.

Table 7 Food-based goals of the DASH diet
Source: U.S. Department of Health and Human Services 2006

Foods	Daily servings (2,000kcal/day)	Daily servings (1,600kcal/day)
Grains (mostly wholegrain)	6-8	6
Vegetables	4-5	3-4
Fruits	4-5	4
Fat-free or low-fat milk and milk products	2-3	2-3
Lean meats, poultry, and fish (including eggs)*	6 or less	3-6
Nuts, seeds, and legumes	4-5 per week	3 per week
Fats and oils	2-3	2
Sweets and added sugar	5 or less per week	0

**The recommendation for this category was previously 2 or less servings per day [U.S. Department of Health and Human Services 2003]; any studies carried out before 2006 would have used the previous cut-off in scores measuring adherence to the DASH diet.*

Table 8 Daily nutrient goals used in the DASH studies[†] (for a 2100kcal eating plan)
Source: U.S. Department of Health and Human Services 2006

Nutrient	Goal
Total fat	27% of energy
Saturated fat	6% of energy
Protein	18% of energy
Carbohydrate	55% of energy
Cholesterol	150mg
Sodium	2,300 mg (1,500mg for increased effect)
Potassium	4,700mg
Calcium	1,250mg
Magnesium	500mg
Fibre	30g

[†]*Harsha et al. 1999; Sacks et al. 2001*

In prospective cohort studies that provided information on food intake, those who had the highest DASH scores compared to those with the lowest DASH scores consistently showed that better adherence with the DASH diet was associated with more frequent intakes of fruit, vegetables, low-fat dairy, whole grains and nuts (where available), and less frequent consumption of red and processed meat, and sweetened beverages (see Table 9). They also had lower intakes of total and saturated fat, and higher intakes of fibre. These dietary factors are thought to be associated with a lower risk of developing CVD, and it is therefore not surprising that studies have found a protective effect of the DASH diet.

Table 9: Food consumption and nutrient intakes in participants with highest and lowest DASH scores; prospective cohort studies.

	Nurses' Health Study[1]		Women's Health Study[2]		Cohort of Swedish Men		Swedish Mammography Cohort	
	Lowest quintile	Highest quintile	Lowest quintile	Highest quintile	Lowest quartile	Highest quartile	Lowest quartile	Highest quartile
Food (servings/day)								
Fruits	1.3	3.5	0.8	2.5	1.1	2.6	1.4	3.0
Vegetables	2.2	4.4	2.5	5.5	1.2	2.6	1.8	3.5
Whole grains	0.7	2.1	0.8	2.3	6.2	9.9	3.3	5.2
Nuts	0.5	1.0	0.2	0.6	-	-	-	-
Low-fat dairy	0.6	1.7	0.5	1.7	0.7	2.0	0.6	1.4
Red and processed meat	1.0	0.5	1.0	0.4	1.6	1.0	1.3	0.8
Sweetened beverages	0.3	0.2	0.6	0.1	1.0	0.2	0.4	0.1
Energy and nutrient intakes (g/day)*								
Energy kJ	6824	7991	-	-	11,518	11,192	-	-
Fat, total	-	-	-	-	79.2	69.2	64.4	54.4
SFA	22.0	15.8	-	-	36.5	30.7	29.8	24.4
MUFA	24.4	18.4	-	-	-	-	-	-
PUFA	10.8	10.1	-	-	-	-	-	-
Protein	-	-	-	-	83.9	89.0	67.9	72.6
Carbohydrate	-	-	-	-	268	286	203	221
Fibre	14	22	-	-	21.0	30.6	18.0	26.3

[1]Fung et al. 2008; [2]Fitzgerald et al. 2011; [3]Levitan et al. 2009b; [4]Levitan et al. 2009a; *all energy adjusted except for energy; SFA saturated fatty acids; MUFA monounsaturated fatty acids; PUFA polyunsaturated fatty acids;

SUMMARY:

DASH DIET

- The DASH diet has been associated with lower risk of CHD, although some studies using a more stringent DASH score have not found an association. Factors including smoking, physical activity and BMI could explain some, but not all of the observed association, suggesting people who adhere more closely to a DASH style diet are generally more health conscious.
- The DASH diet is effective in reducing blood pressure in subjects with elevated blood pressure levels, more so when sodium intake is reduced as well.
- The DASH diet has been found to reduce blood levels of total and LDL cholesterol, but also HDL cholesterol. Thus, there was no overall effect on the HDL to total cholesterol ratio.

Prudent Diet vs. Western Diet

Two main dietary patterns have been identified from several large observational studies in the US: a prudent dietary pattern and a Western dietary pattern [Hu *et al.* 2000; Fung *et al.* 2001&2004; Heidemann *et al.* 2008; Stricker *et al.* 2012]. The prudent dietary pattern is one that complies well with healthy eating recommendations and typically is high in foods such as vegetables, legumes, fruit, fish and shellfish, poultry, wholegrains and low-fat dairy products. In contrast, the Western dietary pattern is characterised by a higher intake of foods such as red meat, processed meat, refined grains, sweets and desserts, hot chips, and high-fat dairy products.

Cardiovascular disease

In the Health Professionals Follow-up Study, a large US-based cohort study in men, a higher prudent pattern score was associated with a significantly lower risk of CHD. After adjusting for a variety of cardiovascular risk factors, including BMI, smoking, family history of MI, physical activity, alcohol consumption and energy intake, those in the highest quintile of the prudent pattern score had a 30% lower risk compared to those in the lowest quintile. In contrast, a higher Western pattern score was associated with a significantly increased risk of CHD; with those in the highest quintile having a 64% increased risk compared to those in the lowest quintile of Western pattern score [Hu *et al.* 2000]. When only adjusting for age the observed associations were more pronounced, suggesting that those who adhere more closely to a prudent diet are generally more health conscious than those who adhere more closely to a Western diet. However, these factors influenced the

association only a little, meaning that it is likely that dietary factors can explain much of the observed associations.

In the Nurses' Health Study, a large US-based cohort study in women, similar associations were found. Those in the highest quintile of prudent pattern score had a 24% lower risk of developing CHD, and those in the highest quintile of Western pattern score had a 46% higher risk of developing CHD, compared to those in the lowest quintile after adjusting for several other CVD risk factors. When only adjusting for age, the effect size was somewhat larger, again suggesting those who adhere more closely to a prudent diet are generally more health conscious than those who adhered more closely to a Western diet [Fung *et al.* 2001].

Furthermore, the Western pattern was associated with a significantly increased risk of stroke, with those in the highest score quintile having a 58% higher risk than those in the lowest quintile; a significantly increased risk was found for ischemic stroke, but not for haemorrhagic stroke. The observed risk was higher when risk factors including BMI, smoking, history of diabetes, physical activity and energy were not accounted for, suggesting that an unhealthy lifestyle in those with a Western pattern leads to an even higher risk of stroke [Fung *et al.* 2004a]. In a follow-up of the Nurses' Health Study a prudent dietary pattern was associated with a significantly lower risk of cardiovascular (28%) and all-cause mortality (17%), and the Western pattern with a significantly increased risk of cardiovascular mortality (22%) and all-cause mortality (21%) in the highest versus the lowest quintile [Heidemann *et al.* 2008].

In a large European cohort (EPIC Netherlands), the prudent diet pattern was associated with a significantly lower risk of stroke. Those in the highest quartile of prudent pattern score had a 31% lower risk of suffering a stroke compared to those in the lowest quartile. Although there was a tendency for a lower risk of CHD with a higher prudent pattern score, this was not statistically significant. In contrast to findings from earlier prospective studies, no association between Western pattern and CHD or stroke risk was found [Stricker *et al.* 2012]. The study authors highlighted that there were some differences in their findings and the findings of the U.S. based studies in terms of foods associated with the prudent or Western pattern, which may explain the conflicting findings to some extent. In this cohort, adjusting for several lifestyle-related risk factors attenuated the observed associations, again suggesting that those who eat a healthier diet also tend to have a healthier lifestyle.

In another European cohort from the Danish World Health Organization-MONICA (Multinational Monitoring of Trends and Determinants in Cardiovascular Disease) surveys, a prudent dietary pattern was associated with a significantly lower risk of all-cause mortality in both men and women. However, the only statistically significant cardiovascular outcome was a lower

risk of cardiovascular mortality in women. Similarly, the Western dietary pattern was not associated with risk of all-cause mortality, or cardiovascular, IHD and stroke mortality [Osler *et al.* 2001& 2002]. The researchers suggested the lack of significant findings for the Western diet may be partly explained by 'healthy' foods such as rye bread and potatoes featuring in the Western pattern of their study cohort. The researchers also highlighted that all dietary variables were measured with substantial amount of error, which could also be a reason for a lack of significant findings [Osler *et al.* 2001&2002].

The different findings in terms of the association between a Western diet and cardiovascular risk may signify that a typical 'Western diet' may be different in different regions of the world, i.e. it is not one uniform diet. This means that findings relating to a 'Western diet' need to be interpreted with caution and findings from one country may not be applicable to another country.

The INTERHEART Study was a large case-control study carried out in 52 countries. It found a prudent dietary pattern was significantly associated with lower odds of acute MI, whereas a Western dietary pattern was associated with a significantly increased risk of acute MI. A third dietary pattern, an Oriental pattern high in tofu, soy sauce, pickled foods and green leafy vegetables, was not associated with acute MI [Iqbal *et al.* 2008]. Of note, dietary patterns in the INTERHEART study were assessed using a food group frequency questionnaire with only 19 items, and it was not validated against another dietary measure. This means, that the questionnaire has not been tested to see how reliably it measures the actual diet of study participants, thus study results need to be interpreted with caution.

Diabetes

A prudent dietary pattern was not associated with lower risk of type 2 diabetes in the Health Professionals Follow-up Study [van Dam *et al.* 2002], the Nurses' Health Study [Fung *et al.* 2004b], or a Japanese prospective cohort study [Nanri *et al.* 2013]. Conversely, a cross-sectional study in the South of Ireland found that people with a higher prudent score had lower prevalence of insulin resistance [Villegas *et al.* 2004].

Conversely, a Western dietary pattern was associated with a significantly increased risk of type 2 diabetes in the Health Professionals Follow-up Study, with those in the highest quintile of the Western score having a 59% higher risk of developing diabetes compared to those in the lowest quintile [van Dam *et al.* 2002].

In the Nurses' Health Study, a Western diet was also associated with a significantly increased risk of type 2 diabetes (by 49% in highest versus lowest quintile) [Fung *et al.* 2004b].

The Japan Public Health Centre-based Prospective study did not find any significant associations between prudent, Westernised or traditional Japanese pattern and risk of type 2 diabetes [Nanri *et al.* 2013].

Metabolic syndrome

In a prospective study in middle-aged U.S. adults (Atherosclerosis Risk in Communities study), a prudent dietary pattern was not associated with risk of developing metabolic syndrome, whereas a Western dietary pattern was associated with a significantly increased risk of metabolic syndrome. Those in the highest quintile of Western diet score were 18% more likely to develop metabolic syndrome than those in the lowest quintile. When looking at individual food groups, those who consumed meat most frequently (1.94 servings/day) were significantly more likely to develop metabolic syndrome compared to low consumers (0.25 servings/day), whereas highest compared to lowest dairy consumption (3.3 vs. 0.3 servings/day) was associated with a significantly lower likelihood of developing metabolic syndrome. No association was found for fruits and vegetables, whole grains, and refined grains [Lutsey *et al.* 2008]. Cross-sectional analysis of data within the Health Workers Cohort Study, carried out in Mexico, also found no association between a prudent dietary pattern and any of the components of the metabolic syndrome (blood glucose, triglycerides, HDL cholesterol, central obesity, blood pressure). In contrast, a Western dietary pattern was associated with significantly higher odds of having unfavourable levels of all metabolic syndrome components [Denova-Gutierrez *et al.* 2010].

Qualitative aspects of the Prudent and Western dietary patterns in included studies

In the Health Professionals Follow-up Study and the Nurses' Health Study, a high compared to a low prudent diet score was associated with more frequent consumption of fruits, vegetables, whole grains, fish, poultry and low-fat dairy products. This was linked with lower intakes of saturated (20-21g vs. 24-29g/day) and monounsaturated fat (20-24g vs. 24-31g/day), and higher fibre intakes (21-28g vs. 12-15g/day). In contrast, those with the highest compared to lowest Western diet scores had a more frequent consumption of red and processed meat, eggs, butter, high-fat dairy products, refined grains, and sweets and desserts, while intakes of fruit, vegetables, low-fat dairy products and whole grain were similar. Overall, high compared to low scorers had higher intakes of saturated fat (24-28g vs. 20g/day), monounsaturated fat (24-30g vs. 20-23g/day), and lower fibre intakes (15-18g vs. 18-25g/day) [Hu et al. 2000, Fung et al. 2001]. Table 10 highlights that those who scored high in the Prudent diet score had a more favourable intake of foods and nutrients compared to those who scored high in the Western diet score.

Table 10: Food consumption and nutrient intakes in participants with highest scores of Prudent and Western dietary pattern; prospective cohort studies

	Health Professionals Follow-up Study[1]		Nurses' Health Study[2]	
	Highest Prudent score	Highest Western score	Highest Prudent score	Highest Western score
Food (servings/day)				
Fruits	3.1	1.8	2.4	1.3
Vegetables	5.4	3.0	5.3	3.2
Whole grains	1.7	1.2	1.5	0.8
Refined grains	1.1	1.9	1.1	2.1
Low-fat dairy	1.0	0.9	1.4	0.8
High-fat dairy	0.9	1.7	1.1	1.7
Red meat	0.5	1.0	0.6	1.0
Processed meat	0.3	0.7	0.3	0.6
Fish	0.6	0.3	0.5	0.3
Poultry	0.5	0.3	0.5	0.3
Eggs	0.3	0.6	0.4	0.5
Butter	0.3	0.6	0.3	0.7
Sweets and desserts	0.9	1.9	1.0	1.9
Nutrient intakes (g/day)*				
SFA	21	28	20	24
MUFA	24	30	20	24
PUFA	14	14	12	12
Protein	100	90	79	68
Carbohydrate	249	222	190	180
Fibre	28	18	21	15

[1]Hu et al. 2000; [2]Fung et al. 2001; *all energy adjusted; SFA saturated fatty acids; MUFA monounsaturated fatty acids; PUFA polyunsaturated fatty acids;

SUMMARY: PRUDENT AND WESTERN DIET

- Evidence from U.S. based studies suggests that a prudent dietary pattern is associated with a lower risk of CHD, and possibly stroke, whereas a Western dietary pattern is associated with an increased CVD risk. Findings from European studies do not support an association, possibly because the prudent and Western dietary patterns observed in Europe are different to those observed in the US.
- Those eating a diet that is closer to a prudent diet also tend to lead a healthier lifestyle overall, explaining some of the protective association.
- Findings from a small number of US based studies suggest a prudent dietary pattern is not associated with risk of type 2 diabetes, but a Western dietary pattern is associated with an increased risk of type 2 diabetes.
- A Western dietary pattern may be associated with an increased risk of metabolic syndrome.

Asian Diets

Japanese Diet

It was previously reported that a large international cohort study, the Seven Countries Study, provided evidence that a Japanese dietary pattern was associated with lower risk of CHD mortality [see Bremer et al. 1999]. A Japanese dietary pattern is characterised by high intakes of soybean products, fish, seaweeds, vegetables, fruits and green tea, and by a high salt consumption through high intakes of soy sauce, salty soups and various other condiments high in salt [Shimazu *et al.* 2007, Nakamura *et al.* 2008].

Cardiovascular disease

A recent cohort study in a Japanese population confirmed that a Japanese dietary pattern is associated with a significantly lower risk of overall CVD mortality and stroke mortality. Those with highest adherence to the Japanese diet score had a 26% lower risk of dying from CVD and a 36% lower risk of dying from stroke compared to those with lowest adherence [Shimazu *et al.* 2007]. This finding is particularly striking as the high salt intake of the traditional Japanese diet has been suggested to increase risk of hypertension and stroke. No significant association with CHD mortality was found, which the authors suggested may have been due to insufficient statistical power [Shimazu *et al.* 2007].

In another cohort study researchers found that those eating a Japanese diet that is reduced in salt have a lower risk of all-cause, CVD, stroke and acute MI mortality compared to those with a high-salt Japanese diet [Nakamura *et al.* 2008]. However, salt intake was only estimated based on two questions within a non-validated food questionnaire, limiting reliability of its findings.

Diabetes

In the Japan Public Health Center-based Prospective study a traditional Japanese dietary pattern was not associated with a lower risk of type 2 diabetes [Nanri et al. 2013]. In a cross-sectional study in Japanese middle-aged men, better adherence to a Japanese dietary pattern was also not associated with risk of diabetes. However, it was associated with significantly higher odds of having impaired glucose tolerance (39% in the highest compared to the lowest quartile of adherence), and non-significantly higher odds of glucose tolerance abnormality. Although the study authors were unable to explain these findings, they suggested that certain characteristics of the traditional Japanese diet, including high content of refined carbohydrate and low protein content, may adversely affect glucose metabolism [Mizoue et al 2006].

Qualitative aspects of the Japanese diet

In the study by Shimazu et al. [2007], compared to subjects who scored lowest in the Japanese diet score, those with the highest scores had a higher consumption of dairy products, fish, vegetables, soybeans and fruits, whereas consumption of rice was lower in high scorers (Table 11). Consumption of meat was similar between those who adhered more or less to the Japanese diet, but was relatively low overall. Fat intake was lower in those who adhered least to the Japanese diet pattern. No information on fat quality, carbohydrates or dietary fibre was presented.

Table 11: Food consumption and nutrient intakes in those with highest and lowest adherence to a Japanese dietary pattern

	Ohsaki National Health Insurance Cohort Study[1]	
	Lowest score	Highest score
Food (g/day)		
Rice	814	567
Meat	20	22
Dairy products	127	223
Fish	50	96
Vegetables	59	138
Soybeans	64	101
Seaweeds	3	9
Fruits	111	204
Green tea (proportion drinking ≥5 cups/day)	16	44
Energy and nutrient intakes (g/day)*		
Energy kJ	5046	6861
Fat	31	41
Protein	61	74
Sodium	2.4	3.2

[1]Shimazu et al. 2007; *all nutrients energy adjusted except for energy

Japan generally has a lower rate of CVD compared to many Western countries such as the USA, but within Japan there is one region where rates of CVD and other diseases have traditionally been particularly low – the Okinawa region. It is thought that dietary habits of inhabitants of this region contribute to the low incidence rates. The traditional Okinawa dietary pattern is characterised by high intakes of vegetables and legumes (mostly soy in origin), moderate consumption of fish, low consumption of meat and meat products, and low consumption of dairy products. The main staple food is not rice (as is the case in many other Japanese regions) but the sweet potato. This diet is low in energy, rich in omega-3 fatty acids, has a high monounsaturated-to-saturated fatty acid ratio, and emphasises low-GI carbohydrates. The contribution of carbohydrates to total energy intake is particularly high in the traditional Okinawa diet with 85% (compared to 55% in the DASH diet for example), whereas the contribution of protein is low (9% of total energy). Intake of fat and saturated fat is very low in the traditional Okinawa diet with only 6% and 2% of energy, respectively. The macronutrient composition of the modern Okinawa diet is similar to that of the DASH diet, with much lower contribution of carbohydrates to energy intake (58%), whereas protein (15%), fat (27%) and saturated fat (7%) intakes are now higher. These changes have led to increased risk of developing disease and other chronic disease risk factors [Willcox et al. 2009].

Chinese Dietary Patterns

A small number of observational studies have investigated dietary patterns in the Chinese population, and how these relate to cardiovascular disease and risk factors.

Cardiovascular disease

Cross-sectional analysis of data from the 2002 *China National Nutrition and Health Survey* was used to identify dietary patterns that are associated with risk of stroke. A group of researchers identified four distinct dietary patterns within the study population (see Table 12).

The 'Yellow Earth' pattern is characterised by large amounts of wheat products, other cereals such as maize and sorghum, as well as tubers such as (sweet) potatoes. In this pattern, consumption of protein-rich foods such as pork, beef, poultry, seafood, milk and cheese was relatively low. This pattern is typical for the diet of Northern China, and was mainly found in rural areas.

The second pattern is the 'Green Water' pattern, which is typical for Southern China, and is first and foremost characterised by a high consumption of rice. Consumption of vegetables, seafood, pork and poultry is also high, whereas the consumption of dairy products is very low.

The third pattern represents the 'Newly Affluent' consumers, and is characterised by a higher consumption of beef, fruit, eggs, poultry, seafood, tofu and milk.

The consumers of the fourth pattern are called 'Western Adopters' and have a high consumption in a majority of the product categories such as cake, fruit juice, beverages and nuts. This dietary pattern leans strongly on a Western pattern [Zhang et al. 2008; Li et al. 2011].

The highest prevalence of overweight and obesity was found in the 'Newly Affluent' and 'Western Adopter' patterns (39% and 30%, respectively), followed by the 'Yellow Earth' pattern (27%), and was lowest in those eating the 'Green Water' pattern (18%) [Zhang et al. 2008]. These data are crude data and therefore not adjusted for factors such as physical activity, gender or age, which are important determinants of body weight.

In another analysis, compared to the traditional Southern Chinese dietary pattern ('Green Water'), those following a traditional Northern Chinese diet ('Yellow Earth') were significantly more likely to report that they had suffered a stroke (+96%), and so were those eating a Western dietary pattern (+136%, 'Newly Affluent' and 'Western Adopter' combined). When adjusting for age, gender, physical activity level, cooking salt and salted vegetable consumption, as well as other factors, the results for the Western dietary pattern were clearly attenuated (risk was higher by 39%). Risk was further reduced when adjusting for BMI, hypertension, hyperglycemia, and dyslipidemia, and was no longer significant. The likelihood of having had a stroke in those following the traditional Northern Chinese dietary pattern was attenuated to a much lesser extent, and was still statistically significant after adjusting for all factors (+59%) [Li et al. 2011]. This suggests that the increased likelihood of a stroke in those following a Western diet is mainly mediated through factors including body

weight, physical activity pattern, hypertension and dyslipidemia. In contrast, dietary factors seem to impact on stroke risk to a much larger degree in those following a traditional Northern Chinese diet. Further analysis showed that a high salt intake in this dietary pattern partially explains this association, but the authors suggest that possibly other factors such as a high intake of refined carbohydrates may play a role as well [Li et al. 2011]. These findings have to be interpreted with caution, as the occurrence of stroke was self-reported, and no conclusions on the effect of certain dietary patterns based on a cross-sectional analysis can be drawn.

Table 12: Food intake according to dietary patterns identified in the 2002 *China National Nutrition and Health Survey* [He et al. 2009]

	Green Water	Yellow Earth	New Affluence	Western Adopter
Food (g/day)				
Rice and products	400	91	156	233
Wheat and products	26	265	171	99
Other cereals	5	60	27	17
Starchy tubers	18	71	42	31
Pork	48	16	52	65
Beef/lamb	2	3	14	13
Poultry	8	1	13	16
Fish and shrimp	24	3	28	36
Eggs	20	29	47	39
Dairy products	7	15	105	98
Vegetables	309	185	249	273
Fruit	43	51	113	115
Nuts	3	3	9	13
Cake	3	2	13	19
Vegetable oil	30	34	40	38
Juice	3	1	4	33

The Singapore Chinese Health Study, a prospective cohort study in which more than 60,000 participants were recruited, identified two main dietary patterns: a pattern that was high in vegetables, fruits and soy, and a pattern that was rich in dim sum, fresh and processed meats and seafood, noodle and rice dishes, sweetened foods, and deep fried foods ('Dim sum'-pattern).

Those with a high adherence to a vegetable, fruit and soy-rich pattern had higher intakes of soy protein and dietary fibre, and slightly lower intakes of saturated fat, compared with those that scored high in the dim sum and meat-rich dietary pattern (Table 13). The two dietary patterns were very similar in many other aspects, including total carbohydrate, fat and protein intake. The vegetables, fruits and soy-rich dietary pattern had a similar loading to the prudent dietary pattern in the Nurses' Health Study and the Health Professionals Follow-up Study, although in the Chinese study grains are almost exclusively consumed in a refined or processed form, and dairy and non-soy legumes are not prominent [Odegaard et al. 2011a).

Those in the upper 60% of dietary pattern score, characterised by a high intake of vegetables, fruits and soy, had a 19% lower likelihood of dying from CVD, which was statistically significant. Participants with CVD or diabetes at baseline and who were in the upper 20% of dietary pattern score characterised by a high intake of vegetables, fruits and soy had a 16% lower risk of dying from CVD [Odegaard et al. 2011b]. This suggests that those who have already developed CVD or diabetes have to adhere to a healthy dietary pattern more strictly to see a protective effect. However, the authors did not report whether those in the upper 60% of the score also had a lower risk of dying from CVD.

Table 13: Energy and nutrient intakes of those who scored high in the vegetable, fruit and soy-rich pattern and the 'Dim-sum' pattern identified in the Singapore Chinese Health Study [Odegaard et al. 2011a]

	Singapore Chinese Health Study	
Energy and nutrient intakes (% of energy)	Highest score VFS pattern	Highest score 'Dim sum' pattern
Energy kJ	7656-8778	8464-9104
Carbohydrate	56	55
Fat	28	29
SFA	9.6	10.3-10.7
MUFA	9.3	9.5-10.0
PUFA	5.9-6.2	5.0-5.6
Protein	15.6-15.9	15.3-16.0
Soy protein	12.6-13.2	8.8-10.0
Fibre (g/4.2 MJ)	9.3-10.4	6.8-7.9

VFS vegetable, fruit, and soy-rich;

Diabetes

In the Singapore Chinese Health Study, those in the highest quintile of adherence to the diet characterised by a high intake of vegetables, fruits and soy and who have never smoked had a significantly lower (by 25%) risk of developing type 2 diabetes compared to those in the lowest quintile. The results were adjusted for age, sex, physical activity and energy intake. Further adjustment for BMI did not significantly attenuate the results. This reduced risk was not observed in people who were smokers or have ever smoked; a non-significantly increased risk was found in this group. In never smokers, those in the highest quintile of the 'Dim-sum'-pattern had a significantly increased (by 47%) of developing type 2 diabetes. Further adjustment for BMI attenuated the results slightly, but the risk was still significantly higher (38%). No association was found in ever smokers. The study authors suggested that several factors may have contributed to the different effects between non-smokers and ever smokers, including a clustering of unhealthy behaviours, greater abdominal fat accumulation, direct effects of smoking on glucose metabolism and greater oxidative stress in ever smokers compared to never smokers [Odegaard et al. 2011a].

In the Shanghai Women's Health Study, a prospective cohort study, the dietary cluster that was associated with a lower risk of diabetes (by 32% after

adjusting for age, energy intake physical activity, alcohol smoking and hypertension, and by 22% after further adjusting for waist-to-hip ratio and BMI), was characterised by a lower intake of staple foods which are typically refined carbohydrate sources (266g vs. 304g/day) and soy foods (81g vs. 147g/day), and higher intakes of animal protein sources including poultry (14g vs. 9g/day), fish and shellfish (53g vs. 33g/day), and eggs (31g vs. 23g/day), higher intakes of dairy milk (129g vs. 12g/day), and higher intakes of fruits (283g vs. 192g/day) and vegetables (277g vs. 250g/day), compared to the reference cluster [Villegas et al. 2010].

This is supported by previous findings of the study authors, where intake of staple foods, and rice in particular, was associated with a higher risk of diabetes [Villegas et al. 2007]. The authors noted that type 2 diabetes was self-reported and therefore, the results have to be interpreted with caution [Villegas et al. 2010]. In a cross-sectional analysis of the 202 China National Nutrition and Health Survey data, the 'Green Water' cluster had the lowest prevalence of glucose tolerance abnormality (3.9%), whereas the 'New Affluence' pattern had the highest prevalence (8%), and the 'Western Adopter' pattern and 'Yellow Earth' pattern also had a significantly higher prevalence (6.3% and 4.8%, respectively). After adjusting for various factors including smoking, physical activity, family history of diabetes and BMI, only those with a 'New Affluence' pattern had significantly higher prevalence ratios compared to the 'Green Water' pattern [He et al. 2009].

Other Asian Diets

In the INTERHEART study, a large case-control study on acute MI carried out in various regions of the world, an 'Oriental pattern' was identified, which was characterised by high intakes of soy sauce, tofu, green leafy vegetables, pickled foods and eggs. This Oriental pattern was not associated with risk of acute MI. When looking at individual food items, higher intakes of vegetables and fruits was associated with a significantly lower risk of MI, whereas high consumption of meat, fried foods and salty foods was associated with an increased risk of MI [Iqbal *et al.* 2008]. Of note, dietary patterns in the INTERHEART study were assessed using a food group frequency questionnaire with only 19 items, which was not validated, limiting reliability of the findings.

SUMMARY: JAPANESE, CHINESE AND OTHER ASIAN DIETS

- There is limited evidence suggesting that a Japanese pattern may be beneficial for cardiovascular health, although findings have been inconsistent. Reducing the relatively high salt content of a Japanese diet may lead to more beneficial outcomes.
- A diet typical for Northern China, which is high in staple foods including grains and starchy root vegetables, and low in protein-sources, has been associated with a higher risk of stroke compared to a diet typical for Southern China, which is high in rice, vegetables, seafood, pork and poultry.
- A Western dietary pattern was also associated with a higher risk of stroke in Chinese men and women, although this is to a large extent was mediated through factors including body weight, physical activity pattern, hypertension and dyslipidemia.
- In Chinese adults, a dietary pattern high in vegetables, fruits and soy was associated with a lower risk of CVD mortality, and a lower risk of diabetes in never smokers, but not in ever smokers.
- In Shanghai women a dietary pattern characterised by lower intake of staple foods, higher intakes of animal protein sources, and higher intakes of fruit and vegetables was associated with a lower risk of diabetes.

Adherence to Dietary Guidelines and Recommendations

Various dietary patterns seem to have beneficial effects on cardiovascular health, for example the Mediterranean diet or the vegetarian diet. These patterns are not always suitable for everyone. For example, foods typically included in the Mediterranean diet may not always be easily available in countries outside the Mediterranean region, and not everyone wishes to follow a vegetarian diet.

Dietary guidelines and recommendations generally take into account both the healthfulness of the diet and its dietary components, as well as local dietary habits. Dietary guidelines in New Zealand or Australia would be different to dietary guidelines in the Middle East for example. However, dietary guidelines between different countries generally share many common features, e.g. they usually advise high intakes of fruits and vegetables, an emphasis on

wholegrain, limited amounts of processed meats, and limited amounts of added sugar, salt and saturated fat. Several studies have attempted to examine whether adherence to dietary guidelines is associated with disease risk, using various indexes that measure adherence to dietary guidelines.

Cardiovascular disease

The Healthy Eating Index (HEI) was developed to reflect adherence to the 1995 *Dietary Guidelines for Americans*. This score was used in the Health Professionals Follow-up Study (men) and Nurses' Health Study (women). In men, they found greater adherence to components in the HEI was only moderately associated with overall risk of chronic disease in men, although it was associated with a significantly reduced risk of CVD (by 28%) after adjusting for several confounding factors [McCullough *et al.* 2000a]. In women, better adherence to dietary recommendations as measured by the HEI was not associated with overall chronic disease risk, and no significant reduction of CVD risk was found after adjusting for confounding factors [McCullough *et al.* 2000b]. See Table 14 for average dietary intakes in these two cohorts by quintile of HEI score. However, the HEI did not measure several important components of a healthy dietary pattern, which has been suggested as a potential reason for a lack of an association.

Table 14: Dietary intakes of men and women from the Health Professionals Follow-up study and the Nurses' Health Study, according to quintile of HEI

	Health Professionals Follow-up Study[1]		Nurses' Health Study[2]	
	Q1	**Q5**	**Q1**	**Q5**
Milk (servings/d)	1.4	1.8	1.0	1.8
Fruit (servings/d)	1.4	4.5	1.2	4.0
Vegetables (servings/d)	3.7	5.4	3.3	5.3
Grains (servings/d)	3.7	5.6	3.1	5.0
Meats (servings/d)	2.9	2.7	2.1	2.3
Total fat (%energy)	38.4	27.1	40.2	29.6
Saturated fat (%energy)	13.9	8.9	14.9	10.3
Monounsaturated fat (%energy)	14.8	10.2	16.5	11.8
Polyunsaturated fat (%energy)	6.3	5.5	8.1	6.7
Dietary fibre (g/d)	14.9	27.5	11.8	23.5
Glycemic load	99	151	77	141
Sodium (g/d)	3.5	3.0	1.9	1.7

[1] McCullough *et al.* 2000a; [2] McCullough *et al.* 2000b;

An improved version of the HEI, the alternate HEI (aHEI), was developed to include important components missing from the HEI. For example, in the HEI the meat component did not differentiate between red meat, poultry and fish, and the grains component did not differentiate between wholemeal and refined cereal products [McCullough *et al.* 2000a+b].

The components of the AHEI score included vegetables (excluding potatoes), fruits, nuts and soy protein, ratio of white to red meat, cereal fibre, *trans* fatty acids, polyunsaturated to saturated fatty acid ratio, and moderate alcohol intake. Those in the highest compared to the lowest quintile had a significantly higher white to dark meat ratio (5.6 vs. 07 in men and 3.1 vs. 07 in women) and

higher intakes in nuts and tofu (1.1 vs. 0.2 servings/day in men and 0.7 vs. 0.1 servings/day in women). Cereal fibre intake was also higher (9.0g vs. 5.0g/day in men and 6.6g vs. 4.1g/day in women), whereas intakes of trans-fats were lower (0.9% vs. 1.6% of energy in men and 1.5% vs. 2.2% of energy in women). Intake of fruits and vegetables were similar as reported by McCullough *et al.* 2000a+b. The researchers found that better adherence to dietary guidelines as measured by AHEI was associated with a significantly reduced risk of major chronic disease, mainly due to a significantly reduced risk of CVD, in both the male and female cohort. Risk of CVD was 39% lower in men in the highest quintile of the AHEI score and 28% lower in women in the highest quintile, compared to those in the lowest quintile after adjusting for several potential confounding factors [McCullough *et al.* 2002]. Risk was again generally lower when only age was accounted for, supporting that those who eat a healthier diet also lead healthier lifestyles overall.

An updated AHEI, which is based on the 2005 *Dietary Guidelines for Americans*, was applied at a more recent stage of the Nurses' Health Study and the Health Professionals Follow-up Study. This time the score also included long-chain omega-3 fatty acids, and sugar-sweetened beverages and fruit juice. Using the updated AHEI score, better adherence to dietary recommendations was again associated with a significantly lower risk of major chronic disease, CVD, CHD and stroke in both men and women. The risk reduction for both cohorts combined was 24% for CVD, 31% for CHD and 20% for stroke [Chiuve *et al.* 2012].

Researchers of a UK-based prospective study (Whitehall II) also applied the AHEI (that based on the 1995 *Dietary Guidelines for Americans*) to their study cohort, which consisted of both men and women. Participants in the highest tertile of the AHEI score had a 25% lower risk of all-cause mortality and a 40% lower risk of CVD mortality compared with those in the lowest tertile [Akabaraly *et al.* 2011].

Diabetes

Using the AHEI, adherence to the 2005 *Dietary Guidelines for Americans* was associated with a significantly lower risk of diabetes in both the Health Professionals Follow-up Study (male cohort) and the Nurses' Health Study (female cohort). Men and women in the highest quintile of AHEI score had a 28% and 35% lower risk of developing diabetes [Chiuve *et al.* 2012].

In the CARDIA (Coronary Artery Risk Development in Young Adults) study, a different index to measure adherence to the 2005 *Dietary Guidelines for Americans* was used. The Diet Quality Index (DQI) included total fat intake, saturated fat intake, cholesterol intake, sugar-containing beverages, reduced fat milk or milk alternatives, fruit, vegetables, wholegrains, sodium intake, and alcohol consumption. Adherence to dietary guidelines based on the DQI score was not associated with risk of diabetes [Zamora *et al.* 2011]. Based on their

findings, the study authors suggested that the 2005 *Dietary Guidelines for Americans* may not be effective in lowering the risk of diabetes. This finding is contrary to those from the Nurses' Health Study and the Health Professionals Follow-up Study. Thus the difference may be due to a different dietary score being used rather than the dietary guidelines not being effective. However, this will need to be studied in more detail before any firm conclusions can be made.

The varying findings of studies using different dietary adherence scores suggests that neither of the dietary scores covered all aspects of the dietary guidelines and that more studies will be needed to identify what aspects of the diet are those most closely related to disease risk.

Blood lipids

In a recently published randomised controlled trial, a group of New Zealand hypercholesterolaemic adult men were advised to follow a diet that is based on the Heart Foundation of New Zealand's '9 steps to Eating for a Healthy Heart'. This led to significantly lower intakes of energy (9094kJ during intervention vs. 10 623kJ pre-intervention), fat (27.5% vs. 32.4% of energy), saturated fat (9.7% vs. 12.8% of energy, monounsaturated fat (9.9% vs. 11.3% of energy) and cholesterol (239mg vs. 328mg/day), and to a significantly larger contribution of carbohydrates (49.6% vs. 44.6%) and protein (19.2% vs. 17.8%) to energy intake. Already after four weeks of following this healthy diet, significant improvements were found in blood lipid profiles, with both total cholesterol and LDL cholesterol decreasing and HDL cholesterol increasing significantly. There was also a non-significant trend towards a decrease in plasma triglycerides. No significant effect on anthropometric measures was found, but the time period is likely to be too short to find any significant changes in body composition [Gammon et al. 2013].

SUMMARY: DIETARY GUIDELINES

- Adhering to dietary guidelines has been associated with a reduced risk of CVD. Although there are some conflicting findings from cohort studies, it is possible that these are due to different systems used to measure adherence.
- Those adhering more closely to dietary guidelines tend to lead a healthier lifestyle overall, contributing to a reduced risk.
- Dietary guidelines are generally evidence-based and adherence to these will reduce the risk of disease, including CVD.

Putting the Findings into Context

Dietary patterns that show a protective association with heart health share many features, although some features are very specific for a certain dietary pattern (see Table 15).

One common feature of all dietary patterns associated with a lower risk of CVD is a relatively high intake of fruits and vegetables. The amounts consumed vary between 5 and 10 serves of fruits and vegetables a day. In contrast, the Western dietary pattern was associated with lower intakes (4.3-5 servings per day).

Another common feature of the protective dietary patterns is an emphasis on whole grains. In the DASH diet 6-8 servings of grains per day, mostly whole grains, are recommended. Most observational studies did not report on total grain consumption, but whole grain intakes were generally higher in those adhering to one of the more protective dietary patterns more closely. In one Spanish cohort [Martinez-Gonzales et al. 2009], a high consumption of cereals, mainly as white bread, was associated with a 92% higher risk of CHD, although this was confounded by increased energy intake.

Where an emphasis on dairy products forms part of a dietary pattern associated with a lower risk of CVD, these are typically low-fat or reduced-fat dairy products (e.g. DASH diet and Prudent diet). In the Mediterranean diet dairy products are generally consumed less than in Western dietary patterns.

Heart healthy dietary patterns are typically low in meat, in particular red and processed meat, refined grains, sugar-sweetened beverages and sweets and desserts, whereas these foods feature more heavily in the Western dietary pattern which was linked to a higher risk of CVD.

Looking at the macronutrient level (Table 15), heart healthy dietary patterns contained low to moderate levels of fat (27-40% energy) . The average contribution of fat to energy intake in New Zealand is around 34% [University of Otago 2011]. Levels of saturated fatty acids are also relatively low in heart healthy diets (5-12% of energy), and are lowest in vegans. The moderate fat intakes and moderate to low saturated fatty acids intakes in the protective dietary patterns are likely to contribute to the positive effects on CVD risk factors and CVD risk.

A high intake of olive oil is a main feature of the Mediterranean diet, leading to relatively high contributions of mono-unsaturated fatty acids to total energy intakes. In particular, in Greek cohorts high intakes of mono-unsaturated fatty acids have been found, contributing up to 28% of total energy intake. It has been argued that the relatively high intake of mono-unsaturated fatty acids in a Mediterranean diet, or rather a high ratio of monounsaturated to saturated fatty acids (i.e. replacement of saturated fatty acids with monounsaturated fatty acids), is likely to be partly responsible for any observed heart protective

effects [Tricholpoulou et al. 2009; Ruiz-Canela & Martinez-Gonzales 2011]. However, when the healthy eating index (HEI) was applied to two US-based cohorts, those who had the highest scores (associated with a lower CVD risk) typically had a lower contribution of mono-unsaturated fatty acids to total energy intake than those with the lowest scores (10.2-11.8% vs. 14.8-16.5% of energy). At the same time, intakes of total fat (27.1-29.6% vs. 38.4-40.2%) and saturated fat (8.9-10.3% vs. 13.9-14.9% of energy) were also lower (see Table 14). It is probable that the lower proportion of saturated fatty acids rather than the higher proportion of monounsaturated fatty acids *per se* may contribute to the heart protective association of higher intakes of olive oil.

Nuts and seeds, which are a good source of omega-3 polyunsaturated fatty acids, are also eaten more frequently in diets associated with a lower risk of CVD.

Table 15: Characteristics of different dietary patterns associated with risk of CVD or CVD risk factors.

	Mediterranean diet	Vegetarian and vegan diet	DASH diet	Prudent diet	Western diet*	Japanese diet	Chinese patterns
Food-based characteristics	**Observational studies:** More[†] • Fruits and nuts • Vegetables • Legumes • Fish and seafood • Olive oil Less • Meat • Poultry • Dairy products (typically non-fat reduced) Alcohol in moderation, typically as part of a meal. **Recommendations in PREDIMED study**	**Observational studies:** More • Whole grains • Vegetables • Fruits • Nuts Less • Dairy products • Refined grains • Desserts, sweets No • Meat • Fish • Eggs or dairy products (vegans)	**Observational studies:** More (servings/day) • Fruits: 2.5-3.5 • Vegetables: 2.6-5.5 • Whole grains: 2.1-9.9 • Nuts: 0.6-1 • Low-fat dairy: 1.4-2.0 Less • Red and processed meat: 0.4-1.0 • Sweetened beverages: 0.1-0.2 **Food-based goals of DASH diet:** (servings/day) based on 2000kcal/day	**Observational studies:** More (servings/day) • Fruits: 2.4-3.1 • Vegetables: 5.3-5.4 • Whole grains: 1.5-1.7 • Low-fat dairy: 1.0-1.4 • Fish: 0.5-0.6 • Poultry: 0.5 Less • Refined grains: 1.1 • High-fat dairy: 0.9-1.1 • Red meat: 0.5-0.6 • Processed meat: 0.3 • Eggs: 0.3-0.4 • Butter: 0.3 • Sweets and desserts: 0.9-1.0	**Observational studies:** Less (servings/day) • Fruits: 1.3-1.8 • Vegetables: 3.0-3.2 • Whole grains: 0.8-1.2 • Low-fat dairy: 0.8-0.9 • Fish: 0.3 • Poultry: 0.3 More • Refined grains: 1.9-2.1 • High-fat dairy: 1.7 • Red meat: 1.0 • Processed meat: 0.6-0.7 • Eggs: 0.5-0.6 • Butter: 0.6-0.7 • Sweets and desserts: 1.9	**Observational study:** More (grams/day) • Dairy products: 223g/d • Fish: 96g/d • Vegetables: 138 g/d • Soybeans: 101g/d • Fruits: 204 g/d • Green tea Less: • Rice: 567 g/d Meat intake was similar to those with low Japanese diet scores, but was low overall (20-22g/day).	**Observational study:** (*2002 China National Nutrition and Health Survey*) **Green Water (Southern China):** More (grams/day) • Rice and products: 400g/d • Pork: 48g/d • Fish and shrimp: 24g/d • Vegetables: 309g/d Less: • Cereals: 31g/d • Starchy tubers: 18g/d • Beef/lamb: 2g/d • Eggs: 20g/d • Dairy products: 7g/d

[†] More/Less means that those who adhered better to a certain type of diet had higher/lower intakes of the listed foods compared to people who scored low

	(servings per day or week): More: • Fruits: ≥3/day • Nuts/seeds: ≥3/week • Vegetables: ≥2/day • Legumes/pulses: ≥3/week • Fish and seafood: ≥3/week (especially fatty) • Olive oil: ≥4/day (tablespoons) Less: • Red and processed meat: <1/day; white instead of red meat • Sugar-sweetened beverages: <1drink/day • Commercial bakery goods, sweets, and pastries: <3/week Also recommend wine (≥7glasses/week) with meals, only for habitual drinkers.	[1600 kcal/day]: • Grains, mostly wholegrain: 6-8 [6] • Vegetables: 4-5 [3-4] • Fruits: 4-5 [4] • Fat-free/low-fat dairy products: 2-3 [2-3] • Lean meats, poultry, and fish (including eggs): 6 or less [3-6] • Nuts, seeds, and legumes: 4-5/week [3/week] • Fats and oils: 2-3 [2] • Sweets and added sugar: ≤5/week [0]			• Fruit: 43g/d • Cake: 3g/d **Yellow Earth* (Northern China)** More: (grams/day) • Cereals: 325g/d • Starchy tubers: 71g/d Less: • Rice and products: 91g/d • Pork: 16g/d • Beef/lamb: 3g/d • Poultry: 1g/d • Fish and shrimp: 3g/d • Dairy products: 15g/d • Vegetables: 185g/d • Fruits: 51g/d • Cake: 2g/d
Nutri-ent-based charact eristics	**Observational studies:** Greek cohort: • Fat: 39-40% of energy	**Observational studies:** (EPIC-Oxford cohort) Vegetarians:	**Nutrient goals of DASH diet, used in the DASH trials:** • Fat: 27%E • SFA: 6%E	**Observational studies:** (grams/day, energy adjusted) • SFA: 20-21g/d	**Observational studies:** (grams/day, energy adjusted) • SFA: 24-28g/d	**Observational study:** (grams/day, energy adjusted) • Fat: 41g/d

• SFA: 11-12% of energy • MUFA: 25-28% Spanish cohorts: • Fat: 33-35%E • SFA: 10%E • MUFA: 15-16%E • Protein: 18%E • Carbohydrates: 47%E • Fibre: 27-40g/day	• Energy: 7705-8909kJ • Fat: 30-31%E • SFA: 9%E • PUFA: 5-6%E • Protein: 13-14%E • Carbohydrates: 52-53%E • Fibre (Non-starch polysaccharides): 23-24g/day Vegans: • Energy: 7123-8058kJ • Fat: 29%E • SFA: 5%E • PUFA:8%E • Protein: 13%E • Carbohydrates: 55-56%E • Fibre (Non-starch polysaccharides): 27-28g/day **RCT:** Vegans: • Fat: 22%E • SFA: 5%E • MUFA: 8%E • PUFA: 7%E • Protein 15%E • Carbohydrates: 66%E • Fibre: 22g/day	• Protein: 18%E • Carbohydrate: 55%E	• MUFA: 20-24g/d • PUFA: 12-14g/d • Protein: 79-100g/d • Carbohydrate: 190-249g/d • Fibre: 21-28g/d	• MUFA: 24-30g/d • PUFA: 12-14g/d • Protein: 68-90g/d • Carbohydrate: 180-222g/d • Fibre: 15-18g/d	• Protein: 74g/d

*Associated with higher risk of CVD and less beneficial impacts on CVD risk factors;

The contribution of carbohydrates in dietary patterns that are associated with a lower risk of CVD is typically around 45-55% of energy, although it is higher in vegans (66%). However, the dietary pattern that is typical for the Northern parts of China contains large amounts of (mostly refined) cereals and starchy tubers and only little amounts of animal protein sources. This dietary pattern has been associated with less beneficial impacts on CVD risk factors and CVD risk. This suggests high intakes of refined starchy foods may increase the risk of CVD, although the evidence does not consistently show this. Also, it is difficult to conclude from studies looking at dietary patterns overall what amount of carbohydrate is associated with a lower or higher CVD risk.

Intakes of dietary fibre were also generally higher in dietary patterns associated with lower risk of CVD, supporting the well-established link between dietary fibre intake and risk of CVD.

In many studies, adjusting for confounding factors including physical activity, BMI, smoking or energy intake, the extent of a protective association was attenuated. This suggests that in many instances, people who follow a diet that has been associated with a lower risk of CVD often lead a more healthy lifestyle overall, and some of the positive effects may be mediated by these healthier lifestyle factors. Several strengths and limitations of the evidence on dietary patterns and CVD need to be highlighted. A major strength of looking at dietary patterns as a whole is that a large array of possible components affecting health are taken into account. However, it is difficult to disentangle the contribution of different single factors to the overall association with health. Also, the type of studies that typically investigate an association between diet and disease in primary prevention are epidemiological studies that do not allow conclusions on the effect of certain components. In addition, potential confounding factors including lifestyle, family history of disease and other factors may not be appropriately accounted for, which could skew the findings.

It is also difficult to establish an exact amount of certain foods and components that may be associated with a reduced risk of CVD, as the levels used in the different studies can vary significantly, also depending on the population that was investigated.

Nevertheless, overall, these studies provide a good evidence base that certain dietary patterns that share several common features are associated with a lower risk of disease, which is to some extent mediated by a generally healthier lifestyle.

Conclusion

The pattern of food we eat can promote or protect against disease. Various dietary patterns have been associated with a reduced risk of CVD, including CHD and stroke. These include the Mediterranean and vegetarian dietary patterns, and to some extent the DASH and prudent dietary patterns. These dietary patterns reflect a range of macronutrient intakes but share features such as a large proportion of plant foods (vegetables, fruit, wholegrains, legumes, nuts). Conversely, certain animal products, particularly those high in fat and saturated fat, and other foods high in refined carbohydrates and sugar are usually limited or completely excluded in these types of dietary pattern. Taken together, these dietary patterns highlight the importance of quality of food choices, for example type of fat and carbohydrate, rather than a set proportion of energy intake. They also highlight the importance of certain components of dietary patterns such as vegetables and fruit, legumes, nuts, wholegrains, and healthy oils.

A Western dietary pattern, characterised by a high proportion of foods such as processed and red meat, refined grains, sweets and desserts, hot chips, and high-fat dairy products, has been associated with an increased risk of CHD and stroke.

Acknowledgements

We would like to thank the Food & Nutrition Working Group of the Heart Foundation for their peer review of this paper.

References

Akbaraly TN, Ferrie JE, Berr C, Brunner EJ, Head J, Marmont MG *et al.* Alternative healthy eating index and mortality over 18 y of follow-up: results from the Whitehall II cohort. *Am J Clin Nutr* 2011;94:247-53.

Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM *et al.* A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;336:1117-24.

Appleby PN, Davey GK, Key TJ. Hypertension and blood pressure among meat eaters, fish eaters, vegetarians and vegans in EPIC-Oxford. *Public Health Nutr* 2002;5(5):645-654.

Bach A, Serra-Majem L, Carrasco JL, Roman B, Ngo J *et al.* The use of indexes evaluating the adherence to the Mediterranean diet in epidemiological studies: a review. *Public Health Nutr* 2006;9(1A):132-146.

Barnard ND, Jenkins DJA, Turner-McGrievy G, Gloede L, Green A, Ferdowsian H. A low-fat vegan diet and a conventional diabetes diet in the treatment of type 2 diabetes: a randomized, controlled, 74-wk clinical trial. *Am J Clin Nutr* 2009a;89(suppl):1588S-96S.

Barnard ND Katcher HI, Jenkins DJA, Cohen J, Turner-McGrievy G. Vegetarian and vegan diets in type 2 diabetes management. Nutr Rev 2009b;67(5):255-263.

Bates B, Lennox A, Bates C, Swan G. National Diet and Nutrition Survey. Headline Results from Years 1 and 2 (Combined) of the Rolling Programme (2008/2009-2009/2010). Department of Health and Food Standards Agency: London.

Berkow SE, Barnard ND. Blood pressure regulation and vegetarian diets. *Nutr Rev* 2005;63(1):1-8.

Blumenthal JA, Babyak MA, Hinderliter A, Watkins LL, Craighead L, Lin PH *et al.* Effects of the DASH diet alone and in combination with exercise and weight loss in blood pressure and cardiovascular biomarkers in men and women with high blood pressure. The ENCORE study. *Arch Intern Med* 2010a;170(2):126-135.

Blumenthal JA, Babyak MA, Sherwood A, Craighead L, Lin PH, Johnson J *et al.* Effects of the Dietary Approaches to Stop Hypertension diet alone and in combination with exercise and caloric restriction on insulin sensitivity and lipids. *Hypertension* 2010b;55:1199-205.

Bray GA, Vollmer WM, Sacks FM, Obarzanek E, Svetkey LP, Appel LJ. A further sub-group analysis of the effects of the DASH diet and three dietary sodium

levels on blood pressure: results of the DASH-sodium trial. Am J Cardiol 2004;94:222-227.

Bremer J, Chisholm A. Dietary patterns. An evidence-based nutrition statement from the National Heart Foundation of New Zealand's Nutrition Advisory Committee. National Heart Foundation: Auckland, 1999.

Buckland G, Gonzalez CA, Agudo A *et al.* Adherence to the Mediterranean diet and risk of coronary heart disease in the Spanish EPIC cohort study. *Am J Epidemiol* 2009;170:1518-29.

Chang-Claude J, Hermann S, Eilber U, Steindorf K. Lifestyle determinants and mortality in German vegetarians and health-conscious persons: results of a 21-year follow-up. *Cancer Epidemiol Biomarkers Prev* 2005:963-968.

Chen ST, Marathur NM, Appel LJ. The effect of dietary patterns on estimated coronary heart disease risk. Results from the Dietary Approaches to Stop Hypertension (DASH) trial. *Circ Cardiovasc Qual Outcomes* 2010;3:484-489.

Chiuve SE, Fung TT, Rimm EB, Hu FB, McCullough ML, Wang M *et al.* Alternative dietary indices both strongly predict risk of chronic disease. *J Nutr* 2012;142:1009-18.

Couch SC, Saelens B, Levin L, Dart K, Falciglia G, Daniels S. The efficacy of a clinic-based behavioral nutrition intervention emphasising a DASH-type diet for adolescents with elevated blood pressure. *J Pediatr* 2008;152:494-501.

Craig WJ, Mangels AR; American Dietetic Association. Position of the American Dietetic Association: Vegetarian Diets. *J Am Diet Assoc* 2009;109(7):1266-82

Crowe FL, Appleby PN, Travis RC, Key TJ. Risk of hospitalization or death from ischemic heart disease among British vegetarians and nonvegetarians: results from the EPIC-Oxford cohort study. *Am J Clin Nutr* 2013;DOI:10.3945/ajcn.112.044073.

Dauchet L, Kesse-Guyot E, Czernichow S, Bertrais S, Estaquio C, Péneau S *et al.* Dietary patterns and blood pressure change over 5-y follow-up in the SU.VI.MAX cohort. *Am J Clin Nutr* 2007;85:1650-6.

De Lorgeril M, Salen P, Martin JL, Monjaud I, Delaye J, Mamelle N. Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: final report of the Lyon Diet Heart Study. *Circulation* 1999;99:779-785.

Denova-Gutierrez E, Castanon S, Talavera JO, Gallegos-Carrillo K, Flores M, Dosamantes-Carrasco D *et al.* Dietary Patterns are associated with metabolic syndrome in an urban Mexican population. J Nutr 2010;140:1855-1863.

Deriemaeker P, Aerenhouts D, De Ridder D, Hebbelinck M, Clarys P. Health aspects, nutrition and physical characteristics in matched samples of institutionalized vegetarian and non-vegetarian elderly (>65 yrs). *Nutr Metab* 2011;8:37.

Estruch R, Ros E, Salas-Salvado J, Covas MI, Corella D, Aros F *et al.* Primary prevention of cardiovasular disease with a Mediterranean diet. N Engl J Med 2013:DOI:10.1056/NEJMoal200303.

Ferdowsian HR, Barnard ND. Effects of plant-based diets on plasma lipids. *Am J Cardiol* 2009;104:947-56.

Fitzgerald KC, Chiuve SE, Buring JE, Ridker PM, Glynn RJ. Comparison of associations of adherence to a Dietary Approaches to Stop Hypertension (DASH)-style diet with risks of cardiovascular disease and venous thromboembolism. *J Thromb Haemost* 2012;10:189-98.

Folsom AR, Parker ED, Harnack LJ. Degree of concordance with DASH diet guidelines and incidence of hypertension and fatal cardiovascular disease. *Am J Hypertens* 2007;20:225-32.

Forman JP, Stampfer MJ, Curhan GC. Diet and lifestyle risk factors associated with incident hypertension in women. *JAMA* 2009;302(4):401-411.

Fung TT, Willet WC, Stampfer MJ, Manson JAE, Hu FB. Dietary patterns and the risk of coronary heart disease in women. *Arch Intern Med* 2001;161:1857-62.

Fung TT, Stampfer MJ, Manson JAE, Rexrode KM, Willet WC, Hu FB. Prospective study of major dietary patterns and stroke risk in women. *Stroke* 2004a;2014-19.

Fung TT, Schulze M, Manson JAE, Willet WC, Hu FB. Dietary patterns, meat intake, and the risk of type 2 diabetes in women. *Arch Intern Med* 2004b;164:2235-40.

Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. *Arch Intern Med* 2008;168(7):713-720.

Fung TT, Rexrode KM, Mantzoros CS *et al.* Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women. *Circulation* 2009;119:1093-100.

Gammon CS, Kruger R, Minihane AM, Conlon CA, von Hurst PR, Stonehouse W. Kiwifruit consumption favourably affects plasma lipids in a randomised controlled trial in hypercholesterolaemic men. *Brit J Nutr* 2013;109:2208-18.

Günther ALB, Liese AD, Bell RA, Dabelea D, Lawrence JM, Rodriguez BL *et al.* Association between the Dietary Approaches to Hypertension diet and hypertension in youth with diabetes mellitus. *Hypertension* 2009;53:6-12.

Harsha DW, Lin PH, Obarzanek E, Karanja NM, Moore TJ, Caballero B. Dietary Approaches to Stop Hypertension: a summary of study results. DASH Collaborative Research Group. *J Am Diet Assoc* 1999;99(8 Suppl):S35-9.

Harsha DW, Sacks FM, Obarzanek E, Svetkey LP, Lin PH, Bray GA *et al.* Effect of dietary sodium intake on blood lipids: results from the DASH-Sodium trial. *Hypertension* 2004;43:393-8.

Heidemann C, Schulze MB, Franco OH, van Dam RM, Mantzoros C, Hu FB. Dietary patterns and risk of mortality from cardiovascular disease, cancer, and all causes in a prospective cohort of women. *Circulation* 2008;118:230-237.

Hoffmann I, Groeneveld MJ, Boeing H, Koebnick C et al. Giessen Wholesome Nutrition Study: relation between a health-conscious diet and blood lipids. *Eur J Clin Nutr* 2001;55:887-895.

Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D, Willet WC. Prospective study of major dietary patterns and risk of coronary heart disease in men. *Am J Clin Nutr* 2000;72:912-21.

Hu FB. Plant-based diets and prevention of cardiovascular disease: epidemiologic evidence. In: Phytochemicals: nutrient-gene interactions. Meskin MS, Bidlack WR, Randolph RK eds. CRC Press, 2006.

Iqbal R, Anand S, Ounpuu S, Islam S, Zhang X, Rangarajan S *et al.* Dietary patterns and the risk of acute myocardial infarction in 52 countries: results of the INTERHEART study. *Circulation* 2008;118:1929-37.

Kahleova H, Matoulek M, Malinska H, Oliyarnik O, Kazdova L, Neskudla T *et al.* Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with Type 2 diabetes. *Diabet Med* 2011;28:549-559.

Kastorini CM, Milionis HJ, Esposito K, Giugliano D, Goudevenos JA, Panagiotakos DB. The effect of Mediterranean diet on metabolic syndrome and its components. A meta-analysis of 50 studies and 534,906 individuals. *J am Coll Cardiol* 2011;57:1299-313.

Key TJ, Fraser GE, Thorogood M, Appleby PN, Beral V, Reeves G *et al.* Mortality in vegetarians and nonvegetarians: detailed findings from a collaborative analysis of 5 prospective studies. *Am J Clin Nutr* 1999;70(suppl):516S-24S.

Key TJ, Appleby PN, Rosell MS. Health effects of vegetarian and vegan diets. *Proc Nutr Soc* 2006;65:35-41.

Key TJ, Appleby PN, Spencer EA, Travis RC, Roddam AW, Allen NE. Mortality in British vegetarians: results from the European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford). *Am J Clin Nutr* 2009;89(suppl):1613S-9S.

Levitan EB, Wolk A, Mittelman MA. Consistency with the DASH diet and incidence of heart failure. *Arch Intern Med* 2009a;169(9):851-7.

Levitan EB, Wolk A, Mittelman MA. Relation of consistency with the Dietary Approaches to Stop Hypertension diet and incidence of heart failure in men aged 45 to 79 years. *Am J Cardiol* 2009b;104:1416-20.

Li Y, He Y, Lai J, Wang D et al. Dietary patterns are associated with stroke in Chinese adults. *J Nutr* 2011;141:1834-1839.

Liese AD, Nichols M, Sun X, D'Agostino RB, Haffner SM. Adherence to the DASH diet is inversely associated with incidence of type 2 diabetes: the Insulin Resistance Atherosclerosis study. *Diabetes Care* 2009;32:1434-6.

Lutsey PL, Steffen LM, Stevens J. Dietary intake and the development of the metabolic syndrome: the Atherosclerosis Risk in Communities study. *Circulation* 2008;117:754-61.

Marathur NM, Wang NY, Appel LJ. Lifestyle interventions reduce coronary heart disease risk: results from the PREMIER trial. *Circulation* 2009;119:2026-31.

Martinez-Gonzalez MA, Garcia-Lopez M, Bes-Rastrollo M *et al.* Mediterranean diet and the incidence of cardiovascular disease: A Spanish cohort. *Nutr Metab Cardiovasc Dis* 2009;21:237-44.

McCullough ML, Feskanich D, Rimm EB, Giovannucci EL, Ascherio A, Variyam JN *et al.* Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in men. *Am J Clin Nutr* 2000a;72:1223-31.

McCullough ML, Feskanich D, Stampfer MJ, Rosner BA, Hu FB, Hunter DJ *et al.* Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women. *Am J Clin Nutr* 2000;72:1214-22.

McCullough ML, Feskanich D, Stampfer MJ, Giovannucci EL, Rimm EB, Hu FB *et al.* Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am J Clin Nutr* 2002;76:1261-71.

McKeown PP, Logan K, McKinley MC, Young IS, Woodside JV. Evidence for the use of the Mediterranean diet in patients with CHD. *Proc Nutr Soc* 2010;69:45-60.

Mente A, de Koning L, Shannon HS, Anand SS. A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. *Arch Intern Med* 2009;169(7):659-669.

Ministry of Health. Food and Nutrition Guidelines for Healthy Adults: A background paper. Ministry of Health, Wellington, 2003.

Mitrou PN, Kipnis V, Thiebaut ACM *et al.* Mediterranean dietary pattern and prediction of all-cause mortality in a US population. Results from the NIH-AARP diet and health study. *Arch Intern Med* 2007;167:2461-68.

Mizoue T, Yamaji T, Tabata S, Yamaguchi K, Ogawa S, Mineshita M, Kono S. Dietary patterns and glucose tolerance abnormalities in Japanese men. *J Nutr* 2006;136:1352-8.

Nakamura Y, Ueshima H, Okamura T, Kadowaki T, Hayakawa T, Kita Y *et al.* A Japanese diet and 19-year mortality: National Integrated Project for Prospective Observation of Non-Communicable Diseases and its Trends in Aged, 1980. *Brit J Nutr* 2009;101:1696-705.

Nanri A, Shimazu T, Takachi R, Ishihara J, Mizoue T, Noda M *et al.* Dietary patterns and type 2 diabetes in Japanese men and women: the Japan Public Health Center-based prospective study. *Eur J Clin Nutr* 2013;67:18-24.

Obarzanek E, Sacks FM, Vollmer WM, Bray GA, Miller ER, Lin PH *et al.* Effects on blood lipids of a blood pressure-lowering diet: the Dietary Approaches to Stop Hypertension (DASH) trial. *Am J Clin Nutr* 2001;74:80-9.

Odegaard AO, Koh W-P, Butler L, Duval S, Gross MD *et al.* Dietary patterns and incident type 2 diabetes in Chinese men and women. *Diabetes Care* 2011a;34:880-885.

Odegaard AO, Koh W-P, Gross MD, Yuan J-M, Pereira MA. Combined lifestyle factors and cardiovascular disease mortality in Chinese men and women: the Singapore Chinese Health Study. *Circulation* 2011b;124:2847-2854.

Osler M, Heitmann BL, Gerdes LU, Jorgensen L, Schroll M. Dietary patterns and mortality in Danish men and women: a prospective observational study. *Brit J Nutr* 2001;85:219-25.

Osler M, Andreasen AH, Heitmann B, Hoidrup S, Gerdes U, Jorgensen LM, Schroll M. Food intake patterns and risk of coronary heart diseasae: a prospetive cohort study examining the use of traditional scoring techniques. *Eur J Clin Nutr* 2002;56:568-74.

Panagiotakos DB, Pitsavos C, Stefandis C. Dietary patterns: A Mediterranean diet score and its relation to clinical and biological markers of cardiovascular disease risk. *Nutr Metab Cardiovasc Dis* 2006;16(8):559-68.

Pettersen BJ, Anousheh R, Fan J, Jaceldo-Siegl K, Fraser GE. Vegetarian diets and blood pressure among white subjects: results from the Adventist Health Study-2 (AHS-2). *Public Health Nutr* 2012;15(10):1909-1916.

Ruiz-Canela M, Martinez-Gonzales MA. Olive oil in the primary prevention of cardiovascular disease. *Maturitas* 2011;68:245-250.

Rumawas ME, Meigs JB, Dwyer JT, McKeown NM, Jacques PF. Mediterranean-style dietary pattern, reduced risk of metabolic syndrome traits, and incidence in the Framingham Offspring Cohort. *Am J Clin Nutr* 2009;90:1608-14.

Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D *et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;344(1):3-10.

SACN (Scientific Advisory Committee on Nutrition).Salt and health. The Stationery Office, Norwich.

Schulze MB, Hoffmann K, Kroke A, Boeing H. Risk of hypertension among women in the EPIC-Potsdam study: comparison of relative risk estiates for exploratory and hypothesis-oriented dietary patterns. *Am J Epidemiol* 2003;158:365-73.

Shimazu T, Kuriyama S, Hozawa A, Ohmori K, Sato Y, Nakaya N *et al.* Dietary patterns and cardiovascular disease mortality in Japan: a prospective cohort study. *Int J Epidemiol* 2007;36:600-9.

Sofi F, Cesari F, Abbate R, Gensini GF, Casini A. Adherence to Mediterranean diet and health status: meta-analysis. *BMJ* 2008;337:a1344.

Sofi F, Abbate R, Gensini GF, Casini A. Accruing evidence on benefits of adherence to the Mediterranean diet on health: an updated systematic review and meta-analysis. *Am J Clin Nutr* 2010;92:1189-96.

Stricker MD, Onland-Moret NC, Boer JMA, van der Shouw YT, Verschuren WMM, May AM *et al.* Dietary patterns derived from principal component- and k-means cluster analysis: long-term association with coronary heart disease and stroke. *Nutr Metab Cardiovasc Dis* 2012; 20(3):157-64.

Thomas HV, Davey GK, Key TJ. Oestradiol and sex-hormone-binding globulin in pre-menopausal and post-menopausal meat-eaters, vegetarians and vegans. *Br J Cancer* 1999;80:1470-5.

Tonstad S, Stewart K, Oda K, Batech M, Herring RP, Fraser GE. Vegetarian diets and incidence of diabetes in the Adventist Health Study-2. Nutr Metab Cardiovasc Dis 2011; doi:10.1016/j.numecd.2011.07.004.

Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P *et al.* Diet and overall survival in elderly people. *BMJ* 1995:311:1457.

Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. *NEJM* 2003;348(226):2599-608.

University of Otago and Ministry of Health. A Focus on Nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey. Ministry of Health, Wellington, 2011.

U.S. Department of Health and Human Services. DASH Eating Plan. Your guide to lowering your blood pressure with DASH. Washington, 2006.

U.S. Department of Health and Human Services 2006. The DASH Eating Plan. Washington, 2003.

Van Dam RM, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk of type 2 diabetes mellitus in U.S. men. *Ann Intern Med* 2002;136:201-209.

Vang A, Singh PN, Lee JW, Haddad EH, Brinegar CH. Meats, processed meats, obesity, weight gain and occurrence of diabetes among adults: findings from Adventist Health Studies. Ann Nutr Metab 2008;52:96-104.

Villegas R, Salim A, Flynn A, Perry IJ. Prudent diet and the risk of insulin resistance. *Nutr Metab Cardiovasc Dis* 2004;14(6):334-43.

Villegas R, Liu S, Gao Y, Yang G, Li H *et al*. Prospective study of dietary carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle-aged Chinese women. *Arch Intern Med* 2007;167:2310-6.

Villegas R, Yang G, Gao Y-T, Cai H, Li H *et al.* Dietary patterns are associated with lower incidence of type 2 diabetes in middle-aged women: the Shanghai Women's Health Study. *Int J Epidemiol* 2010;39:889-899.

Willcox DC, Willcox BJ, Todoriki H, Suzuku M. The Okinawan Diet: health implications of a low-calorie, nutrient-dense, antioxidant-rich dietary pattern low in glycemic load*. J Am Coll Nutr* 2009;28(Suppl):500S-516S.

Yang SY, Li XJ, Zhang W, Liu CQ, Zhang HJ, Lin JR *et al.* Chinese lacto-vegetarian diet exerts favorable effects on metabolic parameters, intima-media thickness, and cardiovascular risks in healthy men. *Nutr Clin Pract* 2012;27(3):392-398.

Zamora D, Gordon-Larsen P, He K, Jacobs DR, Shikany JM, Popkin BM. Are the 2005 Dietary Guidelines for Americans Associated with reduced risk of type 2 diabetes and cardiometabolic risk factors? Twenty-year findings from the CARDIA study. Diabetes Care 2011;34:1183-85.

Zhang X, Dagevos H, He Y, van der Lans I, Zhai F. Consumption and corpulence in China: a consumer segmentation study based on the food perspective. Food Policy 2008;33:37-47.