UNIVERSITY
OF WOLLONGONG
AUSTRALIA

University of Wollongong
Research Online

Faculty of Science, Medicine and Health - Papers

Faculty of Science, Medicine and Health

2014

Dietary patterns may sustain weight loss among adults

Linda Tapsell

University of Wollongong, ltapsell@uow.edu.au

Elizabeth Neale

Landmark Nutrition Pty Ltd, epn579@uow.edu.au

Deborah Nolan-Clark

Landmark Nutrition Pty Ltd, djn297@uow.edu.au

Publication Details

Tapsell, L. C., Neale, E. P. & Nolan-Clark, D. J. (2014). Dietary patterns may sustain weight loss among adults. *Current Nutrition Reports*, 3 (1), 35-42.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library:
research-pubs@uow.edu.au

Dietary patterns may sustain weight loss among adults

Abstract

Sustainable weight loss requires a shift in eating behaviour maintained over a long time period. Research in this area focuses on dietary patterns based on cuisines that emphasise intakes of common core foods or those that target specific nutrients, such as fat. This review examined the literature to identify evidence on dietary patterns that may be effective for sustained weight loss. Medline, Pubmed, Scopus, and ScienceDirect were searched for relevant literature, and 14 trials were reviewed. Overall, Mediterranean, vegetarian, and low-fat dietary patterns were associated with sustained weight loss under energy-restricted conditions. Evidence to support the efficacy of the Mediterranean diet for sustained weight loss without an energy deficit was inconsistent. Core foods emphasised in dietary patterns associated with weight loss included fruit, vegetables, nuts, legumes, whole grains, and olive oil. Further research involving matched behavioural interventions is required to conclusively identify dietary patterns most conducive to sustained weight loss.

Keywords

Dietary patterns, weight loss, Mediterranean diet, low-fat, vegetarian, vegan, prudent, dietary scores, nutrient density, humans, adults

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Tapsell, L. C., Neale, E. P. & Nolan-Clark, D. J. (2014). Dietary patterns may sustain weight loss among adults. *Current Nutrition Reports*, 3 (1), 35-42.

Dietary patterns may sustain weight loss among adults

Linda C Tapsell PhD FDAA¹ (first and corresponding author)

Elizabeth P Neale PhD APD²

Deborah J Nolan-Clark PhD APD²

¹Smart Foods Centre, School of Health Sciences, University of Wollongong, Wollongong, NSW, 2522 Australia, tel: 02 4221 5132, fax: 02 4221 4844, email: ltapsell@uow.edu.au

²Landmark Nutrition Pty Ltd, PO Box 70, Wollongong, NSW 2500, email: deborah@landmarknutrition.com

²Landmark Nutrition Pty Ltd, PO Box 70, Wollongong, NSW 2500, email: elizabeth@landmarknutrition.com

Key words: dietary patterns, weight loss, Mediterranean diet, low-fat, vegetarian, vegan, prudent, dietary scores, nutrient density, humans, adults

Word count: 3,994

Abstract

Sustainable weight loss requires a shift in eating behaviour maintained over a long time period. Research in this area focuses on dietary patterns based on cuisines that emphasise intakes of common core foods or those that target specific nutrients such as fat. This review examined the literature to identify evidence on dietary patterns that may be effective for sustained weight loss. Medline, Pubmed, Scopus and ScienceDirect were searched for relevant literature, and 14 trials were reviewed. Overall, Mediterranean, vegetarian and low-fat dietary patterns were associated with sustained weight loss under energy restricted conditions. Evidence to support the efficacy of the Mediterranean diet for sustained weight loss without an energy deficit was inconsistent. Core foods emphasised in dietary patterns associated with weight loss included fruit, vegetables, nuts, legumes, wholegrains and olive oil. Further research involving matched behavioural interventions is required to conclusively identify dietary patterns most conducive to sustained weight loss.

Introduction

Desirable weight loss may be achieved in any number of ways, but the central principle remains that total dietary energy must remain less than energy expenditure [1]. The main benefits of weight loss however lie in sustained weight loss and the achievement of metabolic health [2]. This implies shifts in eating behaviour that are sustained for long periods of time, usually assessed at a minimum of one year. Whether changed behaviour is the result of a consistent and definable eating pattern, remains open for debate, but research appears to imply this may be the case. Research in this area tends to define dietary patterns in terms of the types of foods consumed (eg staple food groups), or alternatively the dietary nutrient profile (eg low fat) which can be achieved using any number of combinations of different foods. Either way, understanding the interrelationships between foods, whole diets, and nutrients remains an integral part of studying and interpreting effects of dietary patterns on health.

Evidence for the effects of dietary patterns can be obtained from population based observational studies exposing associations between eating patterns and weight status over time, but direct evidence is provided from randomised controlled trials (RCTs) that test hypotheses relating to changes in dietary patterns and sustained weight loss. Both these forms of research present with limitations, but a consistent trend in results provides confidence in identifying particular effective patterns. There are a number of ways of assessing dietary patterns, using both *a priori* and *a posteriori* forms of analysis of dietary data [3]. Dietary patterns may be studied in terms of cuisines with known common foods, such as Mediterranean style patterns, or plant based diets. They may also be examined in terms of nutrient content, such as low fat diets, or they may be compared as contrasting patterns based on discriminatory sets of foods, such as the Prudent versus Western style diets [3, 4]. As weight loss is predicated in achieving an energy imbalance, it remains to be seen whether certain pattern(s) of dietary intake may be more conducive to sustained weight loss. The aim of this review was to examine the literature on dietary patterns to identify which patterns may be effective in sustained weight loss.

Methods

Medline, Pubmed, Scopus and ScienceDirect databases were searched up to September 2013 using the search terms: “dietary patterns”, “diet scores”, “cluster analysis”, “factor analysis”, “Mediterranean diet”, “prudent diet”, “Nordic diet”, “nutrient density”, “nutrient quality” AND “weight loss”. Truncations of these terms were used when necessary. The search was

limited to randomised controlled trials involving humans, published in the English language. Additional relevant articles were also sourced from the reference lists of original articles. The process of selection of the articles was based on the PRISMA framework (Figure 1). Clinical trials were studied in the first instance to examine direct effects on weight loss. Key observational studies were then utilised in the discussion. This article does not contain any studies with human or animal subjects performed by any of the authors.

Results and Discussion

The search produced 14 clinical trials (including three sub-analyses of primary studies and one follow-up study) comparing defined forms of dietary patterns. Ten of these focused on the Mediterranean diet pattern, two on vegetarian dietary patterns and two on low fat or other dietary patterns. These studies are discussed below, with reference to key observational literature included throughout this review.

Dietary patterns based on cuisines defined by key foods

The Mediterranean diet is the cuisine based food pattern most commonly studied and reported in the scientific literature. Key foods include olive oil, nuts and vegetables, but there are variations, depending on the region.

Observational studies have demonstrated the health benefits of a Mediterranean style diet [5]. One of the earliest trials to demonstrate the effectiveness of this eating pattern on sustained weight loss was an 18 month RCT comparing energy controlled diets using the Mediterranean pattern (35% energy as fat), with a low fat diet (20% energy as fat) in 101 overweight adults from Boston [6]. After 18 months, the Mediterranean diet group lost on average 7.0kg more than the low fat group (95% CI 5.3,8.7) ($P<0.001$), with both groups showing a 40% drop out rate. At this time the Mediterranean diet group also showed greater compliance (54% active participation) compared to the low fat group (20%) ($P<0.002$). After 30 months follow up in 38% of the Mediterranean diet group, a mean weight loss of 3.5kg was found ($P<0.03$). This group had an increase in vegetable intake, and higher fat intakes from olive oil and nuts. On face value the Mediterranean diet pattern appeared more sustainable because of greater compliance and sustained weight loss. Further research would be informative, particularly studying the reasons given by those who dropped out, and on the impact of the key foods in holding the dietary pattern together for those who remained in the study.

In contrast, a shorter three month study in France [7] did not show a significant difference in weight loss between Mediterranean diet and low fat diet groups, but in this study, dietary advice was given qualitatively supporting ad libitum consumption. Portion size restriction was advised for those with a body mass index (BMI) $>25\text{kg/m}^2$. Thus the impact of study design may need serious consideration in comparing effects. The Mediterranean diet focused on nuts, wholemeal bread, cereals, fruit, vegetables, legumes, olive oil and fish, and some red wine. Participants were provided with tomato paste, olive oil and fibre enriched pasta, and the impact of food provision may be an additional design feature affecting outcomes. The low fat diet focused on fruit, vegetables and low fat dairy and meat and vegetable oils, with no alcohol. On consideration of nutritional qualities, either set of foods could sustain a desired level of energy intake. Dietary change was observed in 169/212 adults, and perhaps not surprisingly, both groups decreased their calorie intake and lost weight. There was no long term follow up. A similar four month trial involving post-partum women from Arizona

(n=102), also found no difference in weight loss between the provision of the Mediterranean diet and the United States Department of Agriculture 'MyPyramid' dietary advice. This finding was observed despite the participants in the Mediterranean diet group showing greater compliance to this dietary pattern with higher MED diet scores ($P=0.006$) in addition to being given walnuts (38g/day) and an emphasis on consumption of olive oil and vegetables [8]. Thus diet quality and/or characteristics may be different but this may not translate to differences in energy intake.

Longer term trials are more informative for examining sustained weight loss. In an Israeli workplace setting, the DIRECT trial compared a Mediterranean style dietary pattern with a low fat and low carbohydrate dietary pattern in participants (n=322) who were followed up at 24 months [9] and again after another four years [10] where 67% were still following their dietary patterns with no difference in retention between groups (n=259). Education and dietary guidance were given via the workplace cafeteria. After 24 months the low fat diet group lost significantly less weight (2.9kg) than the Mediterranean diet group (4.4kg) and the low carbohydrate diet group (4.7kg) ($P<0.001$), but after a further four years all groups suffered weight regain. Participants in the Mediterranean group on average regained the least (1.4kg), compared to the low fat group (2.7kg) and the low carbohydrate group (4.1kg) ($P=0.004$), and thereby lost the most weight in the six year period compared to the other two groups. In the Israeli context (a country in the Mediterranean region), it may be easier to maintain a Mediterranean diet pattern for weight management for longer, particularly when educational and food supply support is provided. Further research on the nature of the educational intervention and the types of food chosen would add to this observation.

The PREDIMED trial is another large long term study of the Mediterranean diet, this time in the Mediterranean region of Spain. The diet, supplemented with nuts or olive oil was compared with American Heart Association dietary guidelines, but there was no deliberate calorie restriction. Thus it was not surprising that sub analyses of n=772 participants at three months [11] and n=187 participants after three years [12] found no significant differences between groups in terms of weight loss. The longer term and full study results may need to be examined after five years, bearing in mind that calorie restriction was not part of this trial [5].

Considering additional lifestyle factors and behavioural support may be an important consideration in examining effects of dietary patterns on sustained weight loss. One study comparing usual care with a treatment protocol of the Mediterranean diet with physical activity and stress management education in n=279 post-menopausal women with type 2 diabetes found a significant difference in BMI between groups after six months ($P=0.015$) [13]. The treatment group reduced BMI by 0.37kg/m^2 and the control group showed an insignificant gain of 0.20kg/m^2 ($P=0.318$), but the treatment would have to be seen as a 'package' in which the Mediterranean diet patterns was only one factor. This issue was also evident in an Italian study randomised, single blind trial involving n=180 men and women with the metabolic syndrome [14]. Participants following the Mediterranean diet for two years showed significant weight loss ($-4.0\pm 1.1\text{kg}$, $P<0.001$). In comparison to a control diet (prudent diet), individuals following the Mediterranean diet lost significantly more weight (2.8kg $P<0.001$) and there was also a significant reduction in body mass index for individuals in the Mediterranean diet group ($-1.2\pm 0.3\text{kg/m}^2$, $P<0.001$), but not the control group. More recently, Esposito et al. [15] reported that this dietary pattern (with or without energy restriction) was associated with a significantly greater weight loss over a two year period than a control diet in n=192 overweight and obese men (mean difference of -11.9kg , $P<0.001$). Importantly, however, in both these studies the Mediterranean diet group was given intensive support including regular sessions with a nutritionist, monthly small-group sessions providing

education on goal setting and reducing caloric intake if required. In contrast the control group were provided with oral and written information regarding healthy food choices but were not provided with a specific individualised program. Again, the dietary intervention could only be seen as part of the package that supported long term behaviour change.

Dietary patterns defined by food exclusions

Vegetarian dietary patterns are recognised by various levels of exclusion of animal products, from red meat to chicken, fish, eggs and milk/ cheese and their ingredient exclusion in other foods. There are only a few relatively short term studies comparing vegetarian diet patterns with controls. In one study in participants with type 2 diabetes from the USA (n=99) the control diet followed the American Diabetes Association (ADA) guidelines which stipulated five core food groups (wholegrain cereals, fruits, vegetables, low fat dairy and meat) [16]. The vegan patterns were based on vegetables, fruits, grains and legumes with avoidance of animal products. After 22 weeks, the vegan diet group lost more weight (6.5 kg versus 3.1 kg, $P=0.001$), and there were indications of a higher compliance in the vegan diet group. This result was confirmed in a more recent study exploring a plant-based dietary pattern following 24 weeks on an energy deficit diet model (-500 kcal/day). Greater weight loss was achieved for a vegetarian diet [-6.2 kg (95% CI -6.6 to -5.3) vs. -3.2 kg (95% CI -3.7 to -2.5) $P=0.001$]. The volume of subcutaneous and visceral fat decreased in both groups after the dietary interventions ($P<0.001$). The addition of exercise resulted in a 2% reduction in subcutaneous fat in the vegetarian group (95% CI -2.9 to -0.7; $P<0.05$), a 2% increase in subcutaneous fat in the control group (95% CI -0.1 to +4.2, $P=0.02$) and a 4% visceral fat loss in the vegetarian group (95% CI -5.8 to -0.2) but not in the control group [17]. With such changes it may be necessary to consider the usual dietary patterns and other lifestyle factors that participants may have had on entering the study. It may be that the degree of change and the simplicity of food category avoidance were also helpful in creating the desired energy deficit.

Dietary patterns based on preferential food choices within food categories

Dietary interventions that do not target a particular cuisine or defined exclusions of food categories may be seen as more flexible and adaptable in a more complex food environment. This was the case in the Women's Health Initiative Dietary Modification Trial [18]. Here, post-menopausal women were randomly assigned to either a low fat diet group ($\leq 20\%$ total energy from fat, n=1217 included in the subset of the analysis reported here) or a usual diet group (n=1836). Despite the diets being ad libitum, from baseline to 12 months, women consuming the low fat diet lost a greater percentage of body fat in comparison to women in the control group ($P<0.001$). After three years the difference was very small ($<1\%$) but remained statistically significant ($P<0.0001$). By six years, weight returned and there was no difference between the groups ($P=0.057$). Nevertheless, using Generalized Estimating Equation statistical modelling, to examine overall mean changes over time, women consuming the low fat diet lost significantly more percentage body fat, fat mass and lean mass than the control group (all $P<0.003$). Significant decreases in percent body fat and fat mass were not observed for African American ($P=0.36$ and $P=0.37$ respectively) or Hispanic women ($P=0.79$, $P=0.92$ respectively).

In a larger sample (n=48835) and longer period of follow up of this trial [19], women following an ad libitum low fat dietary pattern lost weight in the first year (mean of 2.2kg, $P<0.001$) and maintained a lower weight than control women during an average 7.5 years of follow-up (difference, 1.9 kg, $P<0.001$ at 1 year and 0.4 kg, $P=0.01$ at 7.5 years). There were

differences in weight loss based on ethnic background, with 7.5 year decreases in weight between the intervention versus control group only remaining significant for white women. For Asian/Pacific Islander women there was no significant difference in weight between the control and intervention group either throughout the years of the trial or at the final follow up (P=0.99 at final follow up). The results of this study thus suggest that a low fat dietary pattern may have differing effects on individuals depending on their ethnicity. Further research would need to determine whether this may have as much to do with behavioural factors as physiological/genetic influences

Core foods emphasised in dietary patterns associated with significant weight loss in clinical trials are summarised in Table 1.

Table 1: Core foods emphasised in dietary patterns associated with significant weight loss

Foods	Study							
	Barnard et al. [16] (Vegan)	Kahleova et al. [17] (Vegetarian)	Esposito et al. [14,15] (Mediterranean)	McManus et al. [6] (Mediterranean)	Stendell-Hollis et al. [8] (Mediterranean)	Shai et al. [9] and Schwarzfuchs et al. [10]. (Mediterranean)	Toobert et al. [13] (Mediterranean)	Vincent et al. [7] (Mediterranean)
Vegetables	√	√	√	√	√	√	√	√
Fruit	√	√	√	√	√	√	√	√
Legumes	√	√	√		√	√	√	√
Olive oil			√	√	√	√	√	√
Nuts		√	√	√	√	√		√
Fish					√	√	√	
Red meat								
Poultry					√	√	√	
Cheese					√	√		
Milk (low fat)					√			
Yoghurt (low fat)		√			√	√		
Red wine						√		√
Whole grains	√	√	√		√	√	√	√

Retrospective analyses of dietary patterns and weight loss

One of the main problems in conducting dietary trials is compliance with the dietary pattern intended. Recent publications are now examining retrospectively the food patterns followed by participants who lost the most weight. In the Woman's Health Initiative Dietary Modification trial [18], for example there was a trend for greater weight loss with increased fruit and vegetable intake, lower fat intake and higher fibre intake in both groups. There was also a trend for greater weight loss with increased percentage of energy from carbohydrate (P<0.001 for both intervention and control groups).

The PREDIMED trial assessed compliance with the Mediterranean diet using a 14-item questionnaire that produced a comparable score, with the key foods shown in Table 2. In a cross-sectional analysis (n=7,447; age 55 – 80 years) significant inverse associations were found between adherence to the Mediterranean dietary pattern and BMI (males: $P=0.001$, females: $P<0.001$), waist to height ratio (males and females: $P<0.001$) and waist circumference (males and females: $P<0.001$). These associations remained statistically significant following multivariable analysis controlling for confounders such as age, physical activity and total energy intake [20]. Now that the five year trial is complete it remains to be seen whether those with the highest Mediterranean diet scores throughout the trial were also those who lost more weight and/or maintained a healthier BMI.

Table 2: Key foods used in Mediterranean diet scoring systems

Key foods	Criterion used in PREDIMED Mediterranean diet scores [20]	Criterion used in EPIC-Spain Mediterranean diet scores [21, 22]
Vegetables	Two or more servings/day	Above 549.9g/day in men and 499.6g/day in women
Fruit and nuts	Fruit (three or more servings /day) Nuts (three or more servings/day)	Fruits and nuts (above 362.5g/day in men and 356.3g/day in women)
Legumes	Three or more servings/ week)	Above 9.1g/day in men and 6.7g/day in women
Fish and/or shellfish	Fish or shellfish (three or more servings/week)	Fish (above 23.7g/day in men and 18.8g/day in women)
Cereals	Not used in scoring system	Above 177.7g/day in men and 139.7g/day in women
Olive oil or monounsaturated fatty acids	Olive oil as main culinary fat (four or more tablespoons/day)	Ratio of monounsaturated fatty acids to saturated fatty acids (above 1.7 for both genders)
Alcohol	Wine (seven or more glasses/week)	Moderate ethanol intakes between 2 – 25g/day in women and 10 – 50g/day in men
Other foods	Sofrito (tomato-based sauce made with onion, leek or garlic and olive oil) (twice or more/week)	
Restricted foods	Red meat (less than one serve/day), with preferential consumption of white meat Butter, cream and margarine (less than one serve/day) Sweet or carbonated beverages (less than one serve/day) Commercial sweets or pastries (less than three serves/week)	Meat (below 120.8g/day in men and 89.8g/day in women)

A different Mediterranean diet score was used in an analysis of the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC) (n=27,827) [21]. This score was based on fish, vegetables, fruit, legumes, cereals and moderate alcohol consumption (Table 2). The ratio of monounsaturated fatty acids to saturated fatty acids was also used to inform the Mediterranean diet score (known as the MD score), as well as lower intakes of meat. Multivariate analyses indicated that high adherence to the Mediterranean dietary pattern (as indicated by the MD score) was associated with significantly decreased incidences of obesity over three years in overweight males (OR: 0.69, 95% CI: 0.54 – 0.89) and females (OR: 0.68, 95% CI: 0.53 – 0.89), after adjusting for underreporting. This relationship also remained significant after adjusting total energy intakes. In comparison, there was no association between adherence to the Mediterranean dietary pattern and the development of overweight in participants who were normal weight at the commencement of the study. These observations inform hypotheses that could be tested in specially designed trials to uncover the behavioural aspects of dietary patterns associated with the Mediterranean cuisine in the weight loss context.

In a recent publication [23] we reported on a cluster analysis of combined data from two Australian weight loss trials targeting specific dietary changes within a background diet congruent with national guidelines (n=231). We found that participants with poor baseline dietary patterns (Cluster 2) lost on average 5.6kg more weight ($P<0.05$) than those starting with dietary patterns more closely aligned to the Australian Guide to Healthy Eating (Cluster 1). The mean baseline energy contribution of non-core foods and drinks such as soft drinks, sweets and takeaway foods was nearly three times higher in Cluster 2 than in Cluster 1 ($P<0.001$) and the three month change in consumption of these items was substantially different (3.65 to 1.17 servings/day Cluster 1 vs. 6.73 to 1.35 servings/day, Cluster 2; $P=0.003$). This analysis showed how shifts in dietary patterns during weight loss can be seen as involving a dual action: increasing desirable foods going into the diet, and taking others out. This two-way shift is worth further exploration in terms of food substitutions and cuisine implications when energy imbalance is a goal.

Dietary scores were also applied in the French SU.VI.MAX study [24] involving 3151 adults. Dietary data was categorised using six different dietary quality scores and compared to changes in weight over a 13 year follow-up. The dietary scores used included the PNNS-GS (a score based on French dietary guidelines), the Diet Quality Index-International (DQI-I), the Dietary Guidelines for Americans Index (DGAII), the Mediterranean Diet Score (MDS), the relative Mediterranean Diet Score (rMED) and the Mediterranean Style Dietary Pattern Score (MSDPS) – a Mediterranean dietary score initially designed for use in the US context [25]. Significant negative associations were found between weight change and all dietary scores in males ($P<0.05$) with the exception of the MSDPS. For all other dietary scores, weight gain in males was found to decrease linearly from the lower to the upper quartiles of dietary results. Whilst some negative associations were found between the MDS, rMED and PNNS-GS dietary scores and weight change in females, these associations were weaker than those seen for males, and became non-significant after adjusting for confounders such as baseline weight and physical activity. Thus there appears to be commonalities amongst diet scores and this may be a focus on core food categories, in particular vegetables, fruits and grains which are staples and tend to be eaten in relatively unprocessed forms. There remains some degree of contextual application however, which reflects the somewhat intangible space between cuisines reduced to food categories and actual meals consumed.

It may be reasonable to assume then, that increasing fruit and vegetable consumption may be a dietary pattern that assists with sustained weight loss. In a recent review of the evidence

[26] we found that trial design played a large part in whether positive results were achieved. It was the case when high vegetable diets were compared with usual diets and in the context of behavioural support, but not when energy intakes were controlled with both groups. It is highly likely that a high vegetable dietary pattern is conducive to weight loss given the variety, high volume and satiety value they provide, but substantial efforts are also likely to be required in assisting with recipes and menu formulations to ensure a full cuisine shift that is sustainable.

In an analysis of several European cohorts in the EPIC study (n=373,808) no significant association was found between increased fruit and vegetable intake (per 100g) and weight change after excluding implausible diet reporting and adjusting for potential confounding variable (P=0.14 for men and P=0.28 for women). However baseline fruit and vegetable intakes were inversely associated with weight change in both men and women who had quit smoking during follow up (P=0.02 for vegetables and P=0.007 for fruit in men, P=0.03 for vegetables in women, P<0.001 for fruit in women) [27]. This again raises the issue of other lifestyle factors that may come into play when dietary patterns are being developed.

Whatever the setting, it appears that certain foods that may form a pattern or cuisine lay at the heart of sustained weight loss and maintenance of healthy weights. Detailed analysis of dietary data from cohorts in the USA have isolated foods such as yoghurt, nuts, fruits, whole grains and vegetables to be negatively associated with weight gain over 4 years, whereas potato chips, potatoes, sugar based beverages and red meats were positively associated with weight gain [28]. It remains to be seen how these foods are consumed, whether as part of a traditional cuisine pattern or as individual foods that are significantly associated with certain patterns of lifestyle.

Conclusions

There is evidence in the literature that adopting certain dietary patterns may help with sustained weight loss. Keeping weight off requires consistent behaviour focused on energy balance. It is associated with a healthy lifestyle, in which food consumption is a major factor. Research into dietary intakes necessarily creates categories which enable the measurement and identification of dietary patterns but this still needs to be translated back into natural settings where foods, meals, recipes, cuisines and individual eating occasions are set. The research discussed throughout this review consistently identified certain core foods that may be referred to as ‘signature foods’ that form the basis of cuisines that may best support sustained weight loss. The core foods consistently associated with weight loss in this context include vegetables, fruit, nuts, legumes, whole grains and olive oil. This may be due to the reduced energy content of a dietary pattern containing these foods as part of an overall cuisine. From a behavioural perspective a whole dietary pattern is easier to maintain than a myriad of individual food choices that occur at random. The reality of sustaining weight loss, however, is that individuals are presented with many circumstances in which they choose to consume food and beverages, and cuisine options may not always be available. What dietary patterns do provide, however, is a form of consistency that may be enough to maintain the equilibrium required for successful weight loss maintenance.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Papers of particular interest, published recently, have been highlighted as:

* of importance

** of particular importance

1. Sacks FM, Bray GA, Carey VJ, Smith SR, Ryan DH, Anton SD et al. Comparison of Weight-Loss Diets with Different Compositions of Fat, Protein, and Carbohydrates. *New England Journal of Medicine*. 2009;360(9):859-73. doi:doi:10.1056/NEJMoa0804748.
2. Pasanisi F, Contaldo F, de Simone G, Mancini M. Benefits of sustained moderate weight loss in obesity. *Nutrition Metabolism and Cardiovascular Diseases*. 2001;11(6):401-6.
3. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Current Opinion in Lipidology*. 2002;13(1):3-9. doi:10.1097/00041433-200202000-00002.
4. Kant AK. Dietary patterns and health outcomes. *Journal of the American Dietetic Association*. 2004;104(4):615-35. doi:10.1016/j.jada.2004.01.010.
5. ** Estruch R, Ros E, Salas-Salvadó J, Covas M-I, Corella D, Arós F et al. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet. *New England Journal of Medicine*. 2013;368(14):1279-90. doi:doi:10.1056/NEJMoa1200303. *This study provides the primary results of the PREDIMED study which evaluated the health outcomes of the Mediterranean dietary pattern.*
6. McManus K, Antinoro L, Sacks F. A randomized controlled trial of a moderate-fat, low-energy diet compared with a low fat, low-energy diet for weight loss in overweight adults. *International Journal of Obesity*. 2001;25(10):1503-11. doi:10.1038/sj.ijo.0801796.
7. Vincent-Baudry S, Defoort C, Gerber M, Bernard M-C, Verger P, Helal O et al. The Medi-RIVAGE study: reduction of cardiovascular disease risk factors after a 3-mo intervention with a Mediterranean-type diet or a low-fat diet. *The American Journal of Clinical Nutrition*. 2005;82(5):964-71.
8. Stendell-Hollis NR, Thompson PA, West JL, Wertheim BC, Thomson CA. A Comparison of Mediterranean-Style and MyPyramid Diets on Weight Loss and Inflammatory Biomarkers in Postpartum Breastfeeding Women. *Journal of Womens Health*. 2013;22(1):48-57. doi:10.1089/jwh.2012.3707.

9. Shai I, Schwarzfuchs D, Henkin Y, Shahar DR, Witkow S, Greenberg I et al. Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. *The New England Journal of Medicine*. 2008;359(3):229-41. doi:http://dx.doi.org/10.1056/NEJMoa0708681.
10. Schwarzfuchs D, Golan R, Shai I. Four-Year Follow-up after Two-Year Dietary Interventions. *The New England Journal of Medicine*. 2012;367(14):1373-4.
11. Estruch R, Martínez-González MAn, Corella D, Salas-Salvadó J, Ruiz-Gutiérrez V, Covas MaI et al. Effects of a Mediterranean-Style Diet on Cardiovascular Risk FactorsA Randomized Trial. *Annals of Internal Medicine*. 2006;145(1):1-11. doi:10.7326/0003-4819-145-1-200607040-00004.
12. Razquin C, Martinez JA, Martinez-Gonzalez MA, Mitjavila MT, Estruch R, Marti A. A 3 years follow-up of a Mediterranean diet rich in virgin olive oil is associated with high plasma antioxidant capacity and reduced body weight gain. *European Journal of Clinical Nutrition*. 2009;63(12):1387-93. doi:10.1038/ejcn.2009.106.
13. Toobert DJ, Glasgow RE, Strycker LA, Barrera M, Radcliffe JL, Wander RC et al. Biologic and Quality-of-Life Outcomes From the Mediterranean Lifestyle Program: A randomized clinical trial. *Diabetes Care*. 2003;26(8):2288-93. doi:10.2337/diacare.26.8.2288.
14. Esposito K, Marfella R, Ciotola M, et al. Effect of a mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: A randomized trial. *JAMA*. 2004;292(12):1440-6. doi:10.1001/jama.292.12.1440.
15. Esposito K, Di Palo C, Maiorino MI, Petrizzo M, Bellastella G, Siniscalchi I et al. Long-Term Effect of Mediterranean-Style Diet and Calorie Restriction on Biomarkers of Longevity and Oxidative Stress in Overweight Men. *Cardiology Research and Practice*. 2011;2011. doi:10.4061/2011/293916.
16. Barnard ND, Cohen J, Jenkins DJA, Turner-McGrievy G, Gloede L, Jaster B et al. A Low-Fat Vegan Diet Improves Glycemic Control and Cardiovascular Risk Factors in a Randomized Clinical Trial in Individuals With Type 2 Diabetes. *Diabetes Care*. 2006;29(8):1777-83. doi:10.2337/dc06-0606.
17. Kahleova H, Matoulek M, Malinska H, Oliarnik 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. *Diabetic Medicine*. 2011;28(5):549-59. doi:10.1111/j.1464-5491.2010.03209.x.
18. Carty CL, Kooperberg C, Neuhouwer ML, Tinker L, Howard B, Wactawski-Wende J et al. Low-fat dietary pattern and change in body-composition traits in the Women's Health Initiative Dietary Modification Trial. *The American Journal of Clinical Nutrition*. 2011;93(3):516-24. doi:10.3945/ajcn.110.006395.
19. Howard BV, Manson JE, Stefanick ML, et al. Low-fat dietary pattern and weight change over 7 years: The women's health initiative dietary modification trial. *JAMA*. 2006;295(1):39-49. doi:10.1001/jama.295.1.39.
20. Martínez-González MA, García-Arellano A, Toledo E, Salas-Salvadó J, Buil-Cosiales P, Corella D et al. A 14-Item Mediterranean Diet Assessment Tool and Obesity Indexes among High-Risk Subjects: The PREDIMED Trial. *PLoS ONE*. 2012;7(8):e43134. doi:10.1371/journal.pone.0043134.
21. Mendez MA, Popkin BM, Jakszyn P, Berenguer A, Tormo MJ, Sánchez MJ et al. Adherence to a Mediterranean Diet Is Associated with Reduced 3-Year Incidence of Obesity. *The Journal of Nutrition*. 2006;136(11):2934-8.
22. Grafenauer SJ, Tapsell LC, Beck EJ, Batterham MJ. Baseline dietary patterns are a significant consideration in correcting dietary exposure for weight loss. *European Journal of Clinical Nutrition*. 2013;67(4):330-6. doi:10.1038/ejcn.2013.26.

23. Lassale C, Fezeu L, Andreeva VA, Hercberg S, Kengne AP, Czernichow S et al. Association between dietary scores and 13-year weight change and obesity risk in a French prospective cohort. *International Journal of Obesity*. 2012;36(11):1455-62. doi:10.1038/ijo.2011.264.
24. Rumawas ME, Dwyer JT, Mckeown NM, Meigs JB, Rogers G, Jacques PF. The Development of the Mediterranean-Style Dietary Pattern Score and Its Application to the American Diet in the Framingham Offspring Cohort. *The Journal of Nutrition*. 2009;139(6):1150-6. doi:10.3945/jn.108.103424.
25. *Tapsell LC, Dunning A, Warensjo E, Lyons-Wall P, Dehlsen K. Effects of Vegetable Consumption on Weight Loss: a review of the evidence with implications for design of randomised controlled trials. *Critical Reviews in Food Science and Nutrition*. 2013:null-null. doi:10.1080/10408398.2011.642029. *This recent review highlights the impact of study design on trial outcomes.*
26. Vergnaud A-C, Norat T, Romaguera D, Mouw T, May AM, Romieu I et al. Fruit and vegetable consumption and prospective weight change in participants of the European Prospective Investigation into Cancer and Nutrition–Physical Activity, Nutrition, Alcohol, Cessation of Smoking, Eating Out of Home, and Obesity study. *The American Journal of Clinical Nutrition*. 2012;95(1):184-93. doi:10.3945/ajcn.111.019968.
27. **Mozaffarian D, Hao T, Rimm EB, Willett WC, Hu FB. Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men. *New England Journal of Medicine*. 2011;364(25):2392-404. *This prospective analysis (which used data from a number of cohort studies) identified key foods associated with weight gain over time.*

Figure 1: Flowchart of the search strategy used in this review