Optimum nutritional strategies for cardiovascular disease prevention and rehabilitation (BACPR)

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ABSTRACT

Nutrition has a central role in both primary and secondary prevention of cardiovascular disease (CVD) yet only relatively recently has food been regarded as a treatment, rather than as an adjunct to established medical and pharmacotherapy. As a field of research, nutrition science is constantly evolving making it difficult for patients and practitioners to ascertain best practice. This is compounded further by the inherent difficulties in performing double-blind randomised controlled trials.

This paper covers dietary patterns that are associated with improved cardiovascular outcomes, including the Mediterranean Diet but also low-carbohydrate diets and the potential issues encountered with their implementation. We suggest there must be a refocus away from macronutrients and consideration of whole foods when advising individuals. This approach is fundamental to practice, as clinical guidelines have focussed on macronutrients without necessarily considering their source, and ultimately people consume foods containing multiple nutrients. The inclusion of food-based recommendations aids the practitioner to help the patient make genuine and meaningful changes in their diet. We advocate that the cardioprotective diet constructed around the traditional Mediterranean eating pattern (based around vegetables and fruits, nuts, legumes, and unrefined cereals, with modest amounts of fish and shellfish, and fermented dairy products) is still important. However there are other approaches that can be tried, including low-carbohydrate diets. We encourage practitioners to adopt a flexible dietary approach, being mindful of patient preferences and other comorbidities that may necessitate deviations away from established advice, and advocate for more dietitians in this field to guide the multi-professional team.

INTRODUCTION

There are multiple modifiable risk factors for cardiovascular disease (CVD), many of which are modifiable via changes in diet and physical activity. This combination is widely recognised in clinical guidelines as being important in both primary and secondary prevention[1-3], and nutritional education is an important element of Cardiac Rehabilitation (CR). However, the area of nutrition is frequently over complicated with conflicting information. Such an example is salt, with recent evidence suggesting the benefit of salt restriction is greatest in those already with hypertension (HTN)[4], and that both low and high intake may be associated with increased mortality[5].

Cardiac patients are becoming increasingly more complex due to the number of comorbidities present. Data from the National Audit of Cardiac Rehabilitation (NACR) shows HTN to be the most common comorbidity (49.9%), followed by hypercholesterolaemia/dyslipidaemia (31.7%) and then diabetes (24.5%)[6]. Poor diet is a significant modifiable risk factor in these comorbidities, and all outcomes reported by the NACR could likely be improved with increased emphasis on addressing lifestyle (nutrition and exercise).

The *Diet working group*, established by British Association for Cardiovascular Prevention and Rehabilitation, was actioned provide a guide through current controversies in cardiovascular nutrition, and to signpost researchers to current gaps in evidence. The group sought views from professionals working in the area of cardiac rehabilitation and aims to provide specific recommendations to answer the many common questions encountered by health care professionals working in this field. This paper reviews both macronutrients and the key food groups health care professionals sought clarity on.

The objectives of this paper are to review the area of cardiovascular nutrition and provide recommendations for practitioners to help patients make healthy eating decisions. We also aim to identify current gaps in evidence and suggestions for future research.

MACRONUTRIENTS

Protein

Summary messages regarding dietary protein are presented in table 1. Detailed study [7-13] analysis examining protein intake and CVD are presented in table 1 (online supplement).

There is a long-standing argument that high protein intakes lead to renal failure with a recent observational study suggesting that increased protein intake post-myocardial infarction (MI) was associated with a greater decline in renal function[7] and increased risk of mortality[8]. Of interest, dairy or plant protein sources showed a much weaker association when compared to animal protein, and the relationship between protein and outcome variables was stronger in those with predisposing disease e.g. diabetes. This indicates that the source of dietary protein may be important to consider. Indeed randomised controlled trials show that the quality of meat (in addition to the whole diet) is likely to be an important factor to consider in explaining this relationship, with evidence suggesting that the addition of lean red meat to an already low saturated fat cardioprotective diet does not impact negatively on blood lipids[9]. The saturated fat content of the comparison diet[10] may be an additional piece of the puzzle in explaining the impact dietary protein (and its source) has on cardiovascular health[11].

Protein provides the main components for muscle synthesis and consensus opinion suggests that protein intakes should be higher in the elderly[12] with intakes up to 1.5 g/kg/d being shown to improve body composition in an elderly, frail population[13]. Collectively these studies highlight an important role for protein in cardiovascular health, especially when considering a) source (animal vs. plant); b) quality, and c) overall diet quality.

CARBOHYDRATES

Summary messages regarding dietary carbohydrate are presented in table 2. Detailed study [14-19] analysis examining carbohydrate intake and CVD are presented in table 1 (online supplement).

The Prospective Urban Rural Epidemiology (PURE) study raised carbohydrates to the forefront of cardiovascular health with headline data showing higher carbohydrate intake was associated with increased all-cause and CV mortality[14]. However recent meta-analyses examining the association between carbohydrate intake and cardiovascular health have suggested a U-shaped relationship between carbohydrate and all-cause mortality, specifically in those consuming a low-carbohydrate diet higher in animal protein and fat[15,16].

Prospective cohort studies have shown fibre intake to be inversely associated with reduced cardiovascular and all-cause mortality post-MI[17]. In this study[17], only cereal fibre was significantly associated with a reduction in cardiovascular and all-cause mortality in both men and women. One of the most prominent sources of cereal fibre is wholegrain, and wholegrain is frequently cited as being beneficial for health[11,18] however there is disparity between meta-analyses of cohort studies and results from randomised controlled trials[19]. Such discrepancy between this and prospective studies likely highlights the importance of adequately defining wholegrain, and taking a whole diet approach when considering cardioprotective foods.

FATS

Summary messages regarding dietary fat are presented in table 3. Detailed study [20-24] analysis examining fat intake and CVD are presented in table 1 (online supplement).

The correct balance of dietary fats is key to cardiovascular health; however, as with carbohydrates and protein types, sources, and amounts have made determining effects difficult. Saturated fat has long been suggested to be harmful for cardiovascular health, however a recent meta-analysis[20] suggested that reducing saturated fat did not seem to effect total mortality or CVD mortality. However, a reduction in combined cardiovascular events of 17 % was shown with a reduction in saturated fat. Greater decreases in events were seen for studies that replaced saturated fat with polyunsatured fats when compared with monounsaturated fats, carbohydrate, or protein[20]. Thus it would appear reducing saturated fat and replacement with unsaturated fat conveys the greatest cardiovascular benefit, not necessarily reducing saturated fat and replacing with refined carbohydrate, and some of this effect may be modified by where the saturated fat is found i.e. dairy vs. processed baked goods.

Increased trans fat intake is positively associated with total mortality, along with animal monounsaturated fats, alpha linolenic acid and arachidonic acid[21]. In this same study, marine n3 polyunsaturated fat and replacement of saturated fat with plant monounsaturated fat was associated with lower total and CVD mortality. This latter study acknowledges the subtypes of fat such as n3 (alpha linolenic acid, eicosapentaenoic acid, and docosahexaenoic acid) and n6 fatty acids (linoleic acid and gamma-linoleic acid). Indeed, n6 fatty acids have been shown to reduce risk of MI, as well as reducing total cholesterol (TC), with these findings possibly relating to both baseline n6 intake and dose of n6 provided[22]. This latter point is similar to observations made in the most recent analysis of fish oil supplements and cardiovascular health. This analysis indicated no benefit from supplementation on reducing fatal CHD or any CVD in people with or at high risk of CVD[23], primarily due to the low dose of eicosapentaenoic acid and docosahexaenoic acid used in the included studies (226 to 1800mg/day and 0 to 1700mg/day, respectively). These null results contrast substantially with the positive effects seen with the Reduction of Cardiovascular Events with Icosapent Ethyl–Intervention Trial (REDUCE-IT) utilising a highly purified form of eicosapentaenoic acid (4g/day)[24]. Further research into specific fat replacements for saturated fat is warranted and it is unclear whether there is additional benefit to maintaining a lower saturated fat diet whilst on lipid-lowering treatment. As with protein and carbohydrate, the source of the nutrient (i.e. food) matters.

FOODS AND FOOD GROUPS

Detailed information considering food and food groups are shown in table 2 (online supplement).

Fruits and Vegetables

The grouping of fruits together with vegetables is inaccurate, similarly to the grouping of red and processed meat. This ignores distinct differences between fruits and vegetables in terms of their nutrient profile, and hence their association with disease. Fruits and vegetables high in nutrients are hypothesised to be cardioprotective and have consistently been associated with reduced CVD[25]. Hence, fruits and vegetables are cornerstones of cardioprotective dietary patterns (e.g. dietary approaches to stop hypertension [DASH], Mediterranean) and dietary guidelines ubiquitously recommend them[1-3].

However, a systematic review and meta-analysis[26] is notable whereby there was an inverse association between both reported dietary intake and blood concentrations of vitamin C, carotenoids, and α-tocopherol (markers of fruit and vegetable intake) with risk of CVD, and all-cause mortality. Interestingly, inverse associations between disease/mortality endpoints were stronger for measured biomarkers than for reported dietary intake suggesting that the methodology used to collect this information may be a unreliable[26]. Multiple studies have shown fruits and vegetables to be consistently associated with reduced CHD and stroke incidence, hypertension, and CVD mortality[26,27]. However debate exists on the physical amounts to be consumed, with some suggestions of CHD benefit over 400g/day[26] and others showing little further benefit of over 300g/day[27]. Existing randomised controlled trials have shown inconsistent effects on established cardiovascular risk markers such as inflammation, blood pressure, or lipids[28,29], and some varieties appear to lack evidence of CVD benefit altogether[11, 27]. Indeed, tinned/canned fruit has been positively associated with all-cause and CVD mortality[11,27] although the reasons for this observation are not clear and could potentially reflect socioeconomic status. One review only found cardioprotective effects for raw vegetables[11] however more varieties were associated with reduced all-cause mortality. It is unclear if the lack of cardioprotection is true or due to a lack of high quality research on specific fruits and vegetables (figure 1).

Eggs

Eggs are a rich source of dietary cholesterol, typically containing 150-230 mg/egg. With the exception of eggs, prawns and liver, most foods rich in cholesterol are also high in saturated fat and it is well established that dietary saturated fat influences levels of circulating low-density lipoprotein cholesterol (LDL-C) to a much greater extent than dietary cholesterol in foods[30]. However the association of egg consumption (and dietary cholesterol) with CVD remains controversial and confusing for patients, particularly those with existing heart disease. The lack of good quality evidence to support the restriction of eggs has resulted in a recent changes to guidelines with many removing any reference to limiting egg and cholesterol intake[1, 3], although this is still highlighted in the most recent American guidelines from primary prevention of CVD[2].

In a very recent analysis of prospective cohort data, Zhong et al.[31] indicated higher consumption of eggs and dietary cholesterol was positively associated with incident CVD and all-cause mortality. These findings are inconsistent with those from previous prospective cohort studies[32-35] and a large review of meta-analyses[11] or other prospective studies [26] showing no association or a benefit to egg consumption However, in [31] the effects of egg consumption were modest, and based on self-reported dietary intake at baseline (with an average follow-up of 17 years) in a US population that may not be representative of a UK diet.

In a prospective cohort study of 0.5 million Chinese adults[32], a moderate level of egg consumption (up to <1 egg per day) was significantly associated with lower risk of CVD. This study demonstrated that each one-egg increment per week was associated with an 8% lower risk of haemorrhagic stroke. In a sub-group analysis of diabetic populations greater egg intake was associated with increased rick of CVD and CHD[34,35], The relationship between egg intake and diabetes incidence is not specifically covered here, but the role of egg intake and CVD incidence in people with diabetes requires further consideration made for the overall dietary pattern. However, eggs are a low in calories, high in protein and contain numerous micronutrients. Given their nutrient profile, eggs can form part of a healthy cardioprotective diet (figure 2).

Dairy

Dairy products have received a great deal of attention in terms of their effect on CVD risk primarily due to their saturated fat content of butter, whole milk and yoghurt, and most cheeses. However, there is increasing evidence that suggests dairy products may actually have a neutral or even a beneficial impact on CVD risk, and that some of the uncertainty in evidence may be related to the different types of dairy. This has been shown by Patterson et al.[36] who also highlighted the importance of considering the calcium content of the food. In their analysis, the inverse association between total dairy intake and risk of MI was attenuated by adjustment for calcium with similar observations for cheese and MI risk.

Several recent systematic review and meta-analyses have continued to reinforce the inverse or neutral association between dairy intake and CV health[37-40]. In a thorough review of systematic reviews and meta-analyses, Fontecha et al.[40] confirmed no association between total dairy intake and CVD. When considering specific subtypes of CVD and dairy, high-fat dairy was not associated with CHD risk, whereas low-fat dairy was associated with lower risk. Milk, cheese and yoghurt all appeared to be neutral or inversely associated risk of CHD, stroke, or CVD incidence. This paper also considered biomarkers in addition to the hard endpoints of CHD and stroke. Dairy product consumption was not associated with changes in TC or LDL-C. Similar results were also observed for systolic and diastolic blood pressure.

The effects of dairy intake appear to be relatively modest and in some studies, adjusting for total energy intake and consumption of other food groups (such as fruit, vegetables or red meat) can attenuate previously significant associations. Certain dairy products such as cheese are energy dense which could contribute to weight gain if consumed in excess. However these same foods are high in amino acids known to stimulate muscle growth (leucine) and rich in calcium and phosphorus (figure 3).

Alcohol

The relationship between alcohol consumption and CVD is still a subject of controversial debate in both primary and secondary prevention. Several meta-analysis have indicated inconsistent relationships between alcohol intake and cardiovascular health [41-45]. A recent meta-analysis[41] of 45 studies has shown a significant reduction of CHD mortality for low volume drinkers and current drinkers comparing to abstainers. In all studies combined, low volume alcohol consumption was associated with a significantly lower risk of CHD mortality. However in those studies that excluded participants with heart conditions, low volume consumption was not associated with reduced CHD mortality[41].

Drinking patterns are also important to consider in the context of alcohol intake, and compared with moderate drinkers, those individuals who consumed a moderate volume of alcohol but did so more inconsistently had a higher risk of CHD mortality[43]. This pattern of drinking may partly explain increased risk of an acute MI following a period of higher drinking [44] and indicates that alcohol use does not have a uniformly protective effect against MI. Patterns of high consumption (perhaps reflecting the social context of alcohol consumption such as binge drinking) must be considered.

A criticism of studies in this area is a lack of acknowledgement that alcohol may have a differential effect on specific types of CVD. Consuming >100 g ethanol/week had a higher risk of all-cause mortality although a J-shaped relationship existed for all CVD outcomes[45]. When this was disaggregated, alcohol intake (per 100 g/week higher consumption) was positively associated with stroke, CHD, HF, and fatal hypertensive disease. With MI as the outcome, there was an inverse log-linear association with alcohol intake. These findings demonstrate how the consistency in frequency and low quantity of alcohol may play an essential role in cardioprotection and prevention. More evidence in needed in those individuals with a previous history of MI (figure 4).

WHOLE DIET APPROACHES

Studies considering whole diet approaches for CVD prevention are shown in table 3 (online supplement).

The previous discussions have highlighted the complexities of nutrition. It is the view of the BACPR diet working group that nutrition research – especially that which impact directly on patients – be focussed on food.

Improving diet quality post MI is associated with a reduction in risk for all-cause mortality, with evidence to suggest it is the whole diet – rather than individual components – that drives this association[46]. The most widely studied diet pattern in relation to cardiovascular health is the "Mediterranean" diet (MedDiet), with multiple studies suggesting this diet pattern is associated with lower all-cause mortality in both primary and secondary prevention of CVD[47, 48]. Broadly speaking, this diet pattern contains a high nutrient density, is rich in fibre, has a relatively high intake of fat (predominantly from olive oil), low intake of saturated fat, and a relatively low glycaemic index in comparison to Western diets. Traditionally it is based around vegetables and fruits, nuts, legumes, and unrefined cereals, moderate fish and shellfish, and fermented dairy products in moderate amounts[48] but will clearly differ pending on geographical region (e.g. Spain vs. North Africa). Greater adherence to an "Alternate Mediterranean Diet" characterised by a high intake of vegetables, legumes, fruit, nuts, whole-grain cereals, fish, a high intake of monounsaturated fats, and low consumption of saturated fat, red and processed meats was associated with a pooled relative risk for all-cause mortality of 0.81 in post-MI individuals[47]. In this same study, a 2-point increase in the alternate Mediterranean Diet score was associated with a 7% decrease in all-cause mortality post-MI.

This observed level of risk-reduction is also consistent across many other cohort studies examining the association between MedDiet adherence and all-cause and CV mortality[48]. The authors of this study make a clear point that pizza consumed in non-Mediterranean countries should be considered as a type of fast food as it is high in calories, sodium, and saturated fat due to the manufacturing process. Similarly using canola oil (high in polyunsaturated fat) is technically not part of the traditional MedDiet. This means health care professionals should be prepared to correct preconceived ideas regarding what is and is not, a MedDiet. Aside from oil type, authorities agree large component of the cardioprotective diet is fruit and vegetables. The established DASH diet (rich in fruits and vegetables, whole grains, low-fat dairy, nuts, legumes, and low in red and processed meat) is associated with decreased incidence of stroke, CVD, CHD, diabetes, in addition to improvements in biomarkers such as systolic and diastolic blood pressure, HbA1C and fasting insulin[49]. The most recent analysis of this topic showed a benefit for greater incorporation of healthy plant foods into the diet, although this benefit was not seen with unhealthy sources (such as refined cereals). Compared with the lowest quintile, those individuals in the highest quintile of a plant-based diet had a lower risk of incident CVD, CVD mortality, and all-cause mortality[50]. Significant reductions in CVD and mortality endpoints were not observed with an unhealthy plant-based diet. Comparing these studies, it can be determined that not all plant-based diets are created equal. More research is needed into plant-based diets and their direct effects post-MI.

A growing area of interest is low-carbohydrate diets and a criticism of the studies cited so far is a lack of consideration of patient subgroups (i.e. those with MI vs. those with MI + type 2 diabetes mellitus). In this latter group, more aggressive control of carbohydrate intake may be justified and lead to better clinical outcomes. There is a lack of robust clinical evidence for low-carbohydrate diets post-MI and more research is needed in this field. In one recent study, a very low-carbohydrate diet was effective at improving diabetes-related outcomes (HbA1c and diabetes-related drug use) in addition to reducing triglycerides and increasing high-density lipoprotein cholesterol[51]. The group did exhibit increases in TC and LDL-C which could be argued to be a negative consequence of the diet intervention, especially if extrapolated to a post-MI population. However this same group showed previously that this increase in LDL-C was accompanied by a decrease in LDL particle number and an increase in LDL particle size[52] (suggestive of a more favourable lipid profile). However it is worth highlighting that there is substantial variation in response to low-carbohydrate diets so monitoring of lipids is important. This study was criticised at the time for patients self-selecting their intervention (not randomised to either treatment or control arm) although this in many ways represents a "real world" approach whereby patients are given a choice in their treatment. It is crucial to examine the carbohydrate replacement element and its source (fat vs. protein, and animal or plant sources) as this will also govern the impact this diet pattern has on CV health. Indeed a recent meta-analysis has indicated a plant-based low-carbohydrate diet is inversely associated with lower risk of mortality whereas an animal-based low-carbohydrate diet was positively associated with the same outcome[15]. This highlights the importance for healthcare practitioners to explore diet choices with their patients, and not automatically assume plant-based or low-carbohydrate diets are "good" and "bad", respectively.

CONCLUSION

Recommendations from the working group are summarised in Box 1. Focussing on macronutrients can be problematic with advice such as "reduce saturated fat" and increase monounsaturated and polyunsaturated fats being vague and non-specific. The greatest improvement in cardiovascular outcomes will be seen when patients are provided with food-based advice. This requires those dispensing this information to have an understanding of nutritional science and an appreciation for the patients' comorbidities. Whilst there is a large body of evidence for the role of the MedDiet, additional approaches should be used in the right groups of patients. Low-carbohydrate diets can be carefully planned and be very nutritious, although similar to plant-based diets they can also be poor quality if not planned appropriately. Nutritional advice needs to be patient-focussed, flexible, and should be adapted to each individual with CVD and their other comorbidities. More specialised dietitians are required in this area to guide the multi-professional team and provide guidance and training to those involved in the individual's rehabilitation journey.

Box 1

Summary Recommendations

Key Principles	Examples	Special Considerations
Adequate protein is essential to prevent muscle loss	Good quality animal and plant protein such as lean meat, fish, dairy and nuts	Older people and those with renal disease
Include higher fibre carbohydrate foods	Choose foods high in fibre e.g. wholemeal bread and pasta instead of refined versions. Include non-starchy vegetables	Portion control and reducing total carbohydrate required to improve glycaemia
Advise reductions in saturated fat on an individual basis and acknowledge the source	Reducing processed baked pastry goods is more advantageous than reducing dairy foods for equivalent amount of saturated fat	
Consider dairy intake in the context of the overall diet and health needs	As above	
Consume eggs as part of a reduced saturated fat healthy eating pattern	-	May need to consider amount of egg intake/dietary cholesterol intake in individuals with familial hypercholesterolaemia
Eat foods naturally rich in unsaturated fats	Nuts, seeds, oily fish Extra virgin olive oil is consumed as part of the traditional Mediterranean diet	-
Include plenty of fruit and vegetables	Root vegetables, green leafy vegetables e.g. kale, lettuce, spinach; cruciferous vegetables A variety of fruits should be included	Ideally fresh or frozen fruit unless canned is the only source available Be mindful of total carbohydrate and free sugar content particularly for those with dysglycaemia
For those who drink alcohol to consume within local government recommendations of no more than 14 units/week with 1-2 alcohol free days each week. Avoid binge drinking	-	-
Use a whole diet approach and tailor approaches to individual comorbidities and need	A traditional cardioprotective diet rich in vegetables, fruits, nuts, legumes, unrefined cereals, moderate seafood and fermented dairy food; low amounts of red and processed meats; olive oil as main culinary fat	Consider reducing the carbohydrate content particularly for those with dysglycaemia, and replacing with plant-based proteins and fats

ACKNOWLEDGMENTS

The authors acknowledge their colleagues for their comments and feedback on the manuscript

FUNDING

None

COMPETING INTEREST

The authors declare no competing interests

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Table 1 Protein

Macronutrient	Source and quality	Summary
Protein	Animal and plant Lean animal protein (defined by [9] as <10 g total fat, <5 g saturated fat, and <95 mg cholesterol/100g) is a better choice than fattier types. Sources of animal protein include fish, poultry, meat, eggs, and dairy. Processed meat is also included in this category as a source of protein Sources of plant protein include nuts and seeds (almonds, walnuts, cashews), pulses (including chickpeas, lentils, bean) Animal proteins are complete (contain the 9 essential amino acids) whereas plant proteins do not. This has often led to plant protein being described as low-quality.	Higher intakes post-MI associated with more rapid decline in renal function and increased mortality[7,8]. This was more pronounced with protein derived from meat and less so with protein from dairy, fish, eggs or plant protein[7,8]. Comorbidities such as diabetes are associated with a greater strength of association between higher animal protein intake and the decline in renal function[7], in addition to all-cause mortality[8]. Protein quality (considering total and saturated fat, and cholesterol) is likely an important factor to consider. The addition of lean 500g/week of lean (<10 g total fat, <5 g saturated fat, and <95 mg cholesterol), unprocessed beef or pork (equating to approximately 71g/day) to a cardioprotective diet did not increase cardiovascular risk and improved 10-year cardiovascular risk score when compared to the same cardioprotective diet but with only 200g/week or lean red meat[9]. The comparator diet is important when examining the relationship between protein and CVD[10]. When analysed against plant protein, red meat yielded smaller decreases in TC and LDL-C, but when compared with low-quality carbohydrates or fish, yielded greater decreases in LDL-C and triglycerides. Variation in the definition of “meat” could explain discrepancies in the literature. Some foods listed under meat include “sausage, hamburger and bacon” which have a markedly different nutrient profile to beef, lamb and chicken [7] and hence different relationship with cardiovascular health[11] Protein is vital for muscle development and strength. Higher protein intakes of 1.5 g/kg/d in an elderly population improve appendicular muscle mass, the ratio of appendicular muscle to fat, and increase gate speed comparison to lower protein intakes (0.8g/kg/d). The protein used was predominantly from whey (high in leucine) which provides the stimulus for muscle growth, and no adverse outcomes were reported[12]. Protein is an essential macronutrient and we suggest this should be obtained from a range of plant and animal sources. Those with established renal disease should be particularly mindful of protein intake. Good quality, low fat/low saturated fat/low cholesterol sources of protein should be encouraged as part of a cardioprotective diet

Table 2 Carbohydrate

Macronutrient	Source and Quality	Summary
Carbohydrates	Plant Refined and whole grain breads and cereals, pastas, rice, fruits and vegetables, and cakes, biscuits, and sugar-sweetened beverages Carbohydrate sources that are based around refined white flour should be reduced/avoided and replaced with better quality sources (such as wholegrain cereals and breads, or fruits and vegetables). Education may be required to explain to individuals that carbohydrates are not only found in breads, cereals and pastas, but are also present in numerous vegetables and fruits	Sources of carbohydrate are important to the relationship of carbohydrates with cardiovascular health. Data from the Prospective Urban Rural Epidemiology (PURE) study indicated higher carbohydrate intake was associated with increased mortality although the sources and quality of carbohydrate was poor, likely explaining this relationship[14]. Additionally, the high percentage energy from carbohydrate likely displaced other beneficial nutrients (protein and fat) from the diet. There appear to be different associations between low-carbohydrate high animal fat and protein diets vs. low-carbohydrate high plant fat and protein diets and mortality. A low-carbohydrate diet high in plant fat and protein was not associated with increased mortality, whereas a low-carbohydrate diet high animal fat and protein diet was[15,16]. Higher fibre intake is inversely associated with cardiovascular and all-cause mortality post-MI[17]. Prospective studies support a role for wholegrains in cardiovascular health, with wholegrain bread, pasta, cereals, and oatmeal associated with reduced all-cause mortality, with similar observations for cardiovascular mortality[11,18]. However randomised controlled trials do not support a role for specifically increasing wholegrain consumption to reduce lipids, blood pressure, and body mass index[19]. We recommend that patients are encouraged to consume good quality sources of carbohydrate, such as vegetables and whole grain cereals that are high in fibre as part of a cardioprotective diet. Reducing dietary carbohydrate may be advantageous to those with altered blood glucose control

Table 3 Fat

Macronutrient	Source and Quality	Summary
Fats	Animal and plant Sources of animal fat include fish, poultry, meat, and dairy (including butter, cream and cheese). Eggs are not listed here due to their low fat content. The fatty acid profile can be affected by what the animal has been fed. Grass fed beef tends to have a lower total fat content than grain-fed beef. Fatty fish (mackerel, salmon, sardines, herring and trout contain the n3 polyunsaturated fats eicosapentaenoic acid and docosahexaenoic acid). Meat can also vary substantially regarding total and saturated fat content. Sources of plant fat include nuts and seeds, and vegetables (including oils). The fatty acid profile of oils varies hugely. Oils high in n6 polyunsaturated fats include soybean, sunflower, safflower and walnut. Oils that contain more n3polyunsaturated fats include flaxseed, walnut, and rapeseed. Olive oil contains predominantly n9 monounsaturated fats. Coconut oil (a plant-based oil) contains predominantly saturated fat.	Acknowledgment of the source is vital, especially considering saturated and polyunsaturated fats The effect of reducing saturated fat on cardiovascular outcomes is greater when baseline saturated fat is high and the intervention diet leads to a greater decrease in saturated fat and TC[20]. Reducing saturated fat and replacement with unsaturated fats appears to convey the greatest cardiovascular benefit[20]. Industrial trans fats (found in pastries, cakes, and deep fried foods) should be avoided as they are associated with increased total mortality[21]. Increasing consumption of n6 fatty acids appears to reduce the risk of MI and lower TC but has no significant effect on other cardiovascular outcomes such as CVD events, CHD events, or stroke[22]. Reducing saturated fat and increasing marine polyunsaturated fats (specifically the n3 eicosapentaenoic acid and docosahexaenoic acid) is associated with decreased total and all-cause mortality[21]. Practical advice around this is to encourage individuals to increase consumption of oily fish (fresh or tinned). There appears no benefit from consuming n3 supplements for the prevention of fatal CVD, largely due to the dose of eicosapentaenoic acid and docosahexaenoic acid not being high enough for any substantial benefit on reducing CVD or fatal CHD[23]. Higher, purified doses of eicosapentaenoic acid *do* result in reductions in cardiovascular death[24] and the effect is likely due to a pleiotropic action of eicosapentaenoic acid (lipid lowering, anti-inflammatory, antiplatelet, and antithrombotic actions). Based on meta-analyses, replacement of saturated fat with unsaturated fat appears to convey to greatest benefit for cardiovascular health. However, similar to protein and carbohydrate, manipulation of dietary fat and its constituents (saturated, monounsaturated and polyunsaturated) must acknowledge the source of these nutrients when focussing on cardiovascular health.

Table Legends

Table 1

CVD, cardiovascular disease; LDL-C, low density lipoprotein cholesterol; MI, myocardial infarction; TC, total cholesterol

Table 2

MI, myocardial infarction

Table 3

CHD, coronary heart disease; CVD, cardiovascular disease; MI, myocardial infarction, TC,