Evidence-based nutrition guidelines for the prevention and management of diabetes

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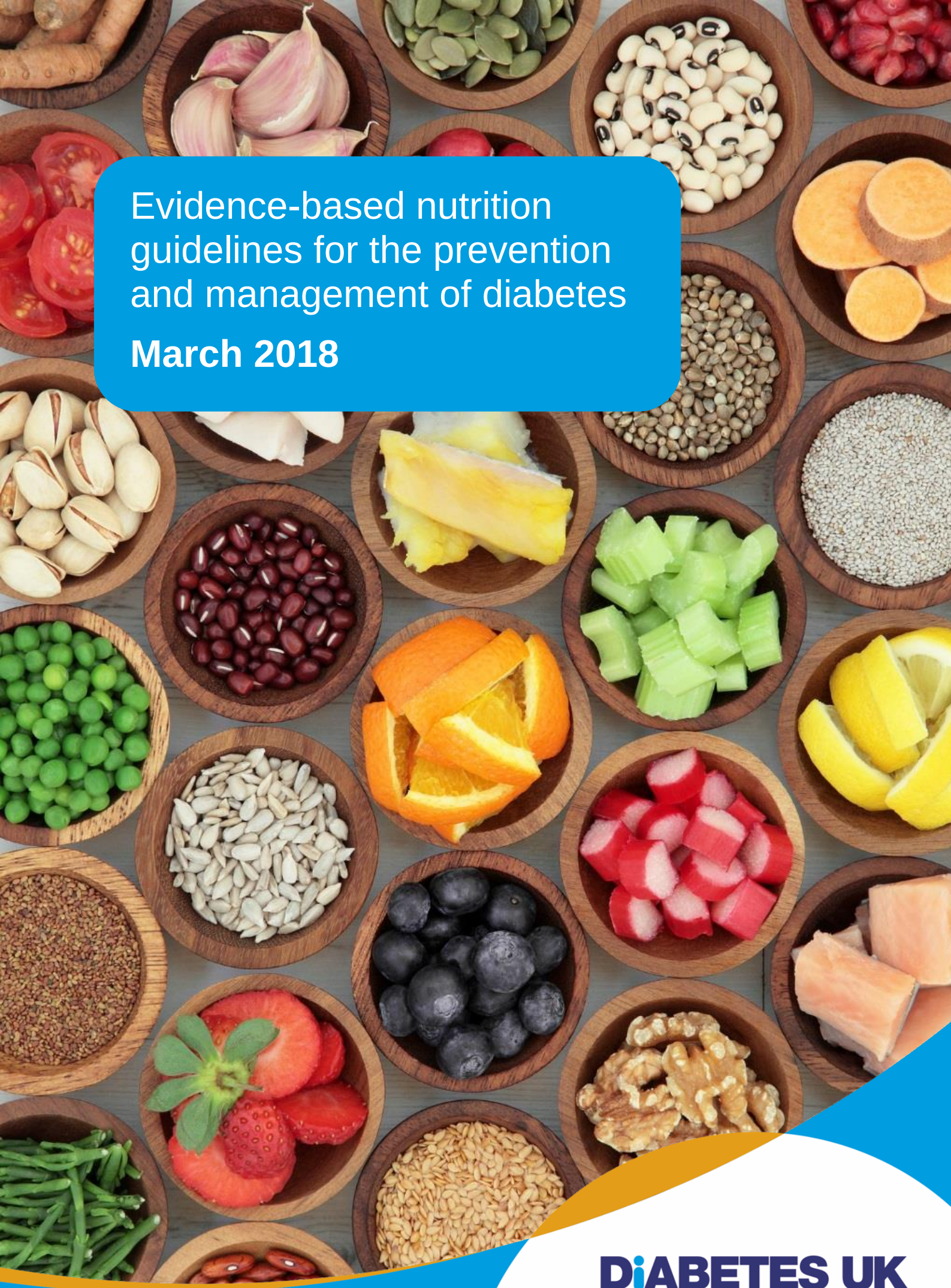

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Contents

Glossary of terms

Suggested term	Description
Added sugar	Describes sugars and syrups that are added to foods during processing or preparation, excluding sugars naturally found in foods, such as fruits or dairy products. Typically ≥10% of energy intake is considered 'high added sugar'.
Bezoars	A solid mass of undigested or partially digested material that accumulates in the gut, which may cause a blockage.
Carbohydrate counting	Calculating total grams of carbohydrate consumed to facilitate accurate matching of mealtime insulin doses in people with Type 1 diabetes who use multiple daily injections (MDI) or continuous subcutaneous insulin infusion (CSII), commonly known as insulin pumps.
Cochrane review	Systematic reviews of research in human health care and health policy which are internationally recognised as the highest standard in evidence-based health care resources.
Commercial weight loss programmes	Weight loss programmes delivered by commercial providers that utilise a variety of interventions including group support, behavioural strategies, dietary advice and physical activity.
Diabetes Specific Formulae (DSF)	Diabetes-specific oral and enteral nutritional supplements that typically contain less carbohydrate and more monounsaturated fatty acids, fructose and fibre than standard nutritional supplements.
Diabetes remission	Achieving non-diabetic HbA1c concentrations without the use of anti-diabetes medications, sustained over a defined period.
Dietary Approaches to Stop Hypertension (DASH) diet	Characterised as higher in foods rich in potassium, calcium and magnesium, such as wholegrains, fruit and vegetables, poultry, fish and low fat dairy and lower in saturated fat, sodium, meats, sweets and sugar-sweetened beverages.
Dietary fibre	Broadly defined as carbohydrates that are resistant to digestion and absorption in the human small intestine, but undergo complete or partial bacterial fermentation in the large intestine. Typically ≥15g/1000kcal or >20g per day is considered 'high fibre' intake. Soluble fibre has glucose and lipid-lowering effects, while insoluble cereal fibre mainly affects bowel function.
Dietary patterns	Description of an overall diet that includes foods and food groups; their combination and variety; and the frequency and quantity with which they are habitually consumed, rather than focusing on individual nutrients or defined ratios of macronutrients.

Enhanced Recovery After Surgery (ERAS)	Multimodal perioperative care protocols designed to achieve early recovery after surgical procedures. Key elements include preoperative counselling, optimisation of nutrition, standardised analgesic and anaesthetic regimens and early mobilization.
Free sugars	Monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates.
Functional foods	Products that claim to deliver additional or enhanced health benefits over and above their original nutritional value. Examples include foods enriched with a particular functional ingredient e.g. yogurt drinks containing pre and probiotics and spreads containing plant stanols and sterols. Other foods may be fortified with a nutrient that would not normally be present in large concentrations e.g. the addition of folic acid to breakfast cereals.
Gastroparesis	Chronic delayed gastric emptying without mechanical obstruction. A neurological complication of diabetes which causes vomiting and weight loss, but which may be intermittent.
Gestational diabetes	Any degree of glucose intolerance with onset or first diagnosis during pregnancy.
Glycaemic index (GI)	A system for the classification of carbohydrate-containing foods that is based on their blood glucose raising potential. It is defined as the incremental area under the glucose response curve to a test food providing a fixed amount of carbohydrate, relative to the response to a standard control food (glucose or white bread) providing the same amount of carbohydrate. Foods are categorised as low (<55), medium (55–69) or high GI (>70).
Healthy eating index (HEI)	A measure of diet quality that assesses conformance to the US Department of Agriculture's Dietary Guidelines for Americans. It assesses adequacy of fruit, vegetables, wholegrains, proteins, dairy, seafood and fatty acids, and moderation of refined grains, sodium and empty calorie foods.
High carbohydrate diet	Variably defined but commonly as intakes of greater than 45% of energy intake from carbohydrate in isocaloric diets.
High monounsaturated fat (MUFA) diet	Generally defined as greater than 20% of energy intake derived from MUFA.
High protein diet	Generally defined as greater than 20–30% of energy intake derived from protein.
Integrated care	Care model incorporating self-management support, delivery system design, clinical information systems and decision support.
Intensive multicomponent lifestyle interventions	Lifestyle interventions that typically combine nutrition, physical activity and behaviour change strategies, delivered with high levels of support from healthcare professionals.
Intermittent energy restriction (IER)	Dietary approach using repeated short periods (usually 2 – 4 days per week) of restriction of energy intake to 400-800 kcal/d, followed by longer periods of habitual diet.

Low carbohydrate diet	Generally defined as below 130g carbohydrate per day (or less than 26% of energy intake from carbohydrate).
Low fat diet	Generally defined as less than 30% of energy intake from total fat per day.
Meal replacement plans	Plans that provide a low calorie diet (800-1200 kcal per day) in which 1-2 meals are replaced by a micronutrient-fortified reduced energy product such as shakes or soups (typically providing 200-400 kcal) and including at least 1 food-based meal per day.
Mediterranean dietary pattern	Dietary pattern characterised as higher in foods rich in MUFA, vegetables, fruits, wholegrains, nuts, fish and legumes; moderate in alcohol (mostly wine consumed with meals); and lower in red and processed meat, sugary foods, refined carbohydrates and processed foods.
mEDI/ Modified Eating Disorder Inventory	Screening tool modified for detecting eating disorders in people with diabetes.
Meta-analysis	A method for systematically combining and analysing the results from separate but similar individual studies in order to test the pooled data for statistical significance.
Mindful eating	A systematic procedure for developing greater awareness without judgment of moment-to-moment experience of physical hunger sensations, satiety cues, perceptions, affective states, thoughts and emotional triggers to eat.
mSCOFF	Modified SCOFF eating disorders screening tool for use in people with diabetes.
Non-nutritive sweeteners (NNS) / Artificial sweeteners	Broadly defined as sweetening agents that provide little or no calories (energy) and have no effect on glycaemia. There are eleven types of NNS licensed for use in the UK, examples include aspartame, saccharine, sucralose, acesulfame-K and cyclamate.
Nordic diet	Diet based on traditional healthy Nordic foods that is higher in fibre, fruit, vegetables, berries, wholegrains, rapeseed oil, fish and low fat dairy; and lower in salt, added sugars and saturated fat.
Nutritive sweeteners	Nutritive sweeteners refer to all sugars that provide energy. The term includes mono- and di-saccharides such as glucose, fructose, sucrose and galactose, as well as polyols (sugar alcohols).
Oily fish	Any variety of fish e.g. salmon, mackerel, sardines that has oil stored throughout its body, including in the flesh, and which is a source of omega-3 fatty acids.
Peer supported education programmes	Programmes that employ support from a person with experiential knowledge of and similar characteristics to the person with diabetes.
Plant based dietary pattern	Dietary pattern characterised as higher in plant-based foods including vegetables, fruits, wholegrains, nuts, seeds and legumes; and lower in animal-based foods including red and processed meats.
Plant sterol and stanol	Compounds found naturally in foods such as vegetables, grains, nuts and seeds. They can be used as ingredients in manufactured

	food products such as yoghurts and spreads to produce a cholesterol-lowering effect as functional foods.
Prudent / healthy eating dietary pattern	Dietary pattern characterised as higher in vegetables, fruit, legumes, whole grains, fibre, fish and poultry; and lower in saturated and trans fat with moderate total fat intake.
Refined carbohydrate	Describes carbohydrate foods that have been highly processed and whose natural structure has been disrupted. In the case of grains, the bran and the germ (which contain fibre and micronutrients) have been removed.
Sarcopenia	The decline of skeletal muscle with age.
SCOFF eating disorders screening tool	Assessment of core features of anorexia nervosa and bulimia nervosa using five questions to evaluate purging (Sick), loss of Control, loss of more than One stone in weight, perception of Fat and Food domination.
Sedentary behaviour	The amount of waking time spent in inactive activities such as sitting to watch TV, sitting behind a computer or lying down.
Small particle size diet	Mashed or pureed food.
Soluble fibre	Defined as viscous or gel-forming dietary fibres that are soluble in aqueous solution. Main value is metabolic, reducing blood glucose and lipids. Includes pectin (found in fruits), β-glucan (found in oats) and inulin (found in vegetables).
South Asian	This refers to people of Bangladeshi, Indian, Pakistani and any other Asian background with the exception of Chinese people.
Structured diabetes education programmes	Diabetes self-management education programmes that meet NICE Quality Standards for structured education.
Systematic review	A literature review that summarises and critically analyses the results of multiple research studies about a specific topic.
Telemedicine	Utilising telecommunications technology for medical diagnosis and health care. It includes using telephones, SMS, videos, and on-line programmes for transmitting and receiving biomedical data and delivering education.
Total Diet Replacement	Diet that provides 800-1200 kcal per day where all dietary intake, other than non-nutritive drinks, is replaced by formula diet, usually made from liquid formula, milk, soups or shakes, and is nutritionally complete providing 100% of dietary reference values for vitamins and minerals.
Very low carbohydrate ketogenic diet	Generally defined as below 50g carbohydrate per day (or less than 10% of energy from carbohydrate).
Very low energy diets (VLED) or Very low calorie diets (VLCD)	Diet that provides <800kcal per day, usually from liquid meal replacement products, which are nutritionally complete and provide 100% of daily reference nutrient intake for vitamins and minerals.
Western dietary pattern	Characterised by a high intake of red and processed meats, convenience foods, refined grains, confectionary and high fat dairy.

Abbreviations

ADA	American Diabetes Association
AHA	American Heart Association
BMI	Body Mass Index
CF	Cystic Fibrosis
CFRD	Cystic Fibrosis related diabetes
CHD	Coronary Heart Disease
CKD	Chronic kidney disease
CSII	Continuous subcutaneous insulin infusion
CV	Cardiovascular
CVD	Cardiovascular disease
DASH	Dietary Approaches to Stop Hypertension
DSF	Diabetes Specific Formulas
DRV	Dietary reference values
EC	European Commission
EDIPS	European Diabetes Prevention Study
EFSA	European Food Safety Authority
EU	European Union
GFR	Glomerular Filtration Rate
eGFR	Estimated Glomerular Filtration Rate
GDM	Gestational diabetes mellitus
GI	Glycaemic index
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HbA1c	Glycated haemoglobin
HDL	High Density Lipoprotein
HIV	Human immunodeficiency virus
IOM	Institute of Medicine
KDIGO	Kidney Disease International Global Outcomes
LDL	Low Density Lipoprotein
MDI	Multiple daily injections

MI	Myocardial infarction
MUFA	Monounsaturated fatty acids
MVPA	Moderate to vigorous physical activity
NICE	National Institute for Health and Care Excellence
OGTT	Oral Glucose Tolerance Test
PARNUTS	Food for particular nutritional uses
PEN	Practice-based Evidence in Nutrition
PUFA	Polyunsaturated fatty acids
RCT	Randomised controlled trial
SACN	Scientific Advisory Committee on Nutrition
SBGM	Self-blood glucose monitoring
SCFA	Short-chain fatty acids
SEEDS	Screen for early eating disorder signs
SFA	Saturated fatty acids
SSB	Sugar-sweetened beverages
TFA	Trans-fatty acids
VLCD	Very Low Calorie Diet
VLED	Very Low Energy Diet

1 Introduction

1.1 Background

Diabetes UK has been publishing dietary guidelines for 35 years, beginning in 1982, with updates and revisions issued at regular intervals in 1992, 2003 and with the most recent previous update in 2011 [1-4]. Each revision reflects advances in the available evidence that impacts changes in approaches to dietary management of diabetes. The strategy applied in these current guidelines is to formulate recommendations from the available evidence highlighting the importance of foods, rather than focusing on individual nutrients, wherever possible. This approach is consistent with a global move towards food-based guidelines, such as in the US and Brazil [5, 6], acknowledging the relevance of foods and overall eating patterns for improved health outcomes. Food-based guidelines also enable advice to be tailored to the individual, both in terms of general culture and personal preference.

These guidelines build upon the previous evidence-based guidance published by Diabetes UK in 2011 [4]. A number of sections have been added and others enlarged to accommodate changes in practice, clinical guidelines and policy priorities. These sections include those such as on ethnic minorities, pregnancy, and prevention of Type 2 diabetes. Additionally, there is a section devoted specifically to dietary sugars, following the Scientific Advisory Committee on Nutrition (SACN) report on Carbohydrates and Health [7]. Effective lifestyle management of diabetes extends beyond dietary behaviours, and the incorporation of physical activity in these guidelines is appropriate due to the interactions between physical activity, dietary patterns and diabetes treatment goals such as glycaemia, blood pressure, lipids and weight management.

1.2 Aims and goals

The overarching aim of this document is to provide evidence-based nutrition recommendations for healthcare professionals to support adults with diabetes, and those at risk of Type 2 diabetes.

There is no one-size-fits-all prescriptive approach to making food choices, and it is equally important that food choices are acceptable and enjoyable while also helping to achieve treatment goals, and improve health and quality of life. Therefore, these recommendations support an individualised approach to promoting healthful food choices.

1.3 Methods

The committee was composed of diabetes specialist dietitians who were recruited for their relevant experience in different areas of diabetes, and committee members took the lead in their specific area of expertise. The majority of dietitians on the committee combined academic and clinical work, providing a mix of theoretical and practical experience. In cases where the committee felt that more expertise was required (HIV and cystic fibrosis

related diabetes), additional specialist dietitians were co-opted to produce these specific sections.

The previous evidence-based guidelines, issued in 2011, had included studies published up to August 2010. These present guidelines incorporate existing evidence and additional studies published between January 2010 and July 2017, although an exception was made to include a major UK study of diabetes remission, published in December 2017.

Relevant studies were identified by electronic searches in EMBASE, MEDLINE and the Cochrane Central Register of Controlled Trials. Reference lists of selected papers were then investigated for any further studies suitable for consideration. Existing guidelines were identified from local, national and international reports.

Search terms and keywords for each section were defined by the dietitian responsible for that section, and these were circulated and agreed by the committee. Inclusion criteria for studies were adults (aged over 18 years) with Type 1 or Type 2 diabetes. Randomised controlled trials, intervention studies and prospective cohort studies, all with a dietary or lifestyle component, were included.

Formal meta-analyses of dietary interventions for diabetes were not undertaken as the majority of studies were at high risk of bias and were heterogeneous in terms of study design, type and intensity of the intervention, the comparator diet or intervention, study length, duration of diabetes and medication use.

1.4 Assessment of strength of recommendations and quality of evidence

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) system, a systematic approach to making judgements about the quality of evidence and strength of recommendations, was used as the basis for grading these dietary recommendations [8]. See Appendix B for more details on application of the GRADE system to these guidelines.

GRADE was selected as it is used both nationally and internationally to formulate nutritional recommendations as applied in practice, and has been formally adopted by Practice-based Evidence in Nutrition (PEN), a recognised global resource for nutrition practice [9]. The value of using GRADE rather than the system based on the hierarchy of research evidence used in previous Diabetes UK guidelines (ranging from (A) recommendations based on systematic reviews and meta-analysis or several good randomised controlled trials (RCTs), through to (D) based on expert consensus) is that it allows for adjustments linked to applicability of data in terms of generalisability and consistency. Although many other grading systems, including those used by the Scientific Advisory Committee on Nutrition (SACN) and the American Diabetes Association (ADA), also allow for these adjustments, GRADE was employed in these guidelines as it is a system widely used for nutritional recommendations and has been adopted globally by about one hundred organisations which formulate recommendations to support healthcare decision making [10]. GRADE also encourages a focus on recommendations that are of primary importance for people living with diabetes, and which are worded in manner that are more person-focused and emphasise eating behaviour and diabetes.

It is acknowledged that much of the evidence from nutrition research is derived from prospective cohort studies rather than randomised controlled trials (RCT), and applying GRADE downgrades evidence from prospective studies when compared to RCTs. This creates challenges when formulating recommendations as all RCTs, even those with high attrition rates and of poor quality may well be rated higher than large, rigorous, high quality prospective studies. This is of most importance when considering the relationship between food and dietary patterns and the risk of developing Type 2 diabetes, where the majority of evidence is derived from prospective cohort studies, as they are the best approach to test the relationship between diet and risk of diabetes. All recommendations made in this main text are evidence-based, and the GRADE score for each is supplied in the summary of recommendations in Appendix A.

1.4 Applicability of the guidelines

These guidelines are written primarily for the UK context. However, the evidence reviewed comes from an international scientific literature and much is applicable internationally, as appropriate but acknowledging regional and national variations. Differences in healthcare systems, social economic and cultural mix meant that some of the findings from the studies reviewed were interpreted in this context.

1. Where studies have used specific terminologies or approaches which are not consistent with the UK population, practical steps were taken to align these. For example, some international studies (e.g. US) report alcohol in number of drinks whereas the UK uses alcohol units. So in such instances, a pragmatic approach was used to convert drinks into units.
2. Where a particular approach (e.g. the use of diabetes specific enteral feeds) is not widely available in the UK, the evidence has been reviewed in the context that if it became widely available, the recommendation would be more applicable.
3. There is currently no consistency in how HbA1c is reported in studies and practice. Therefore, a deliberate decision was taken to report HbA1c in both IFCC-standardised and DCCT-aligned measures to make the guidelines more accessible.
4. For lipids the terms total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides were used as the reviewed published studies reported on these terms. Non-HDL cholesterol, though used as reliable marker of CVD risk, is not widely reported in the literature.

These guidelines apply to all health professionals who deliver care to people with diabetes, especially in the areas of complications, comorbidities and pregnancy. The recommendations have been framed so that they can either be used by healthcare professionals as guidance to support people with diabetes and those at high risk for Type 2 diabetes, or directly applied by people with diabetes where appropriate.

Children are not included in the scope of these guidelines. The current International Society of Paediatric and Adolescent Diabetes (ISPAD) clinical practice guidelines have been adopted by Diabetes UK [11].

2 Nutrition management and models of education and care delivery

RECOMMENDATIONS

- Nutrition management is recommended as part of an integrated package of education and clinical care for all people with diabetes and those at risk of developing Type 2 diabetes.
- Offer on-going nutritional advice guided by a registered dietitian to all people with diabetes, and those at high risk of Type 2 diabetes.
- Offer structured diabetes education at the time of diagnosis with annual follow-up.
- Adopt a person-centred approach and a variety of learning styles during education.

2.1 Impact of nutrition and lifestyle

Intensive multicomponent lifestyle interventions including diet and physical activity have been shown to be effective in delaying the onset of Type 2 diabetes [12, 13] and in achieving treatment goals for risk factors such as glycaemia, lipids, and blood pressure [14-18].

2.2 Impact of dietetic led interventions

Managing diabetes, its complications and associated risk factors and preventing Type 2 diabetes involves complex interventions with many components, where it can be challenging to determine the value of any individual element of care. As a result, it is not always possible to measure the impact of a dietetic intervention separately from other components of diabetes care, although some studies have attempted to do this. In Type 1 diabetes, dietetic interventions resulted in an additional 8mmol/mol (0.7%) HbA1c improvement in people who were newly diagnosed [19] and in Type 2 diabetes HbA1c reductions of 5 – 21mmol/mol (0.49 - 1.9%) have also been reported [20-24]. These interventions are cost-effective [25-27] and associated with fewer visits to physicians and health services, with reductions of 23.5% and 9.5% respectively, on average [28].

It is recommended that a registered dietitian with expertise in diabetes care guides nutrition advice to all people with diabetes and those at high risk of developing Type 2 diabetes.

2.3 Structured diabetes education for Type 1 diabetes

Structured diabetes education programmes are beneficial and clinically effective for individuals with Type 1 diabetes [29, 30] and they have also been shown to be cost effective [31, 32]. Audit data from ongoing national programmes demonstrate improvements in quality of life, diabetes distress, glycaemic control, severe hypoglycaemia and DKA (including hospital admissions) [33, 34]. Structured diabetes education programmes should comply with criteria outlined in National Institute for Health and Care Excellence (NICE) guidance (see signposts).

2.4 Structured diabetes education for Type 2 diabetes and high-risk groups

Structured diabetes education programmes are beneficial and clinically effective for people with Type 2 diabetes demonstrating improvements in glycaemic control, weight loss, quality of life and reducing cardiovascular (CV) risk [35-42], and should comply with criteria outlined in National Institute for Health and Care Excellence (NICE) guidance (see signposts). Self-management group education has been shown to be cost effective in people with Type 2 diabetes [43] and in those at high risk of developing the condition [44].

2.5 Peer supported programmes

A systematic review of RCTs and non-RCTs, including descriptive studies, has concluded that there is less evidence for peer supported programmes [45] which seem to have variable impact on clinical outcomes, self-efficacy and coping. This may be down to the variability in style, method and focus of some of the interventions. However, measuring the value of peer support solely on its impact on glycaemic control may devalue its broader purpose around supporting people to live with diabetes.

2.6 Groups with specific needs

Culturally appropriate health education is more effective than 'usual' health education for people from ethnic minority groups [46, 47]. Educational visual aids are effective tools to support diabetes self-management and are useful when educating individuals whose first language is not English, or for those with sub-optimal literacy skills [36].

2.7 Use of technology

Computer based self-management support (apps, internet programmes), demonstrate variable, small and often non-clinically significant impacts on glycaemic control, but seem to be preferred by some users [48-50]. Text messaging seems to offer slightly more benefit compared to usual care [51]. Telemedicine is an acceptable and feasible form of communication and is another tool that can be used to support people with diabetes, although there is little evidence related to its effect on clinical outcomes [52, 53]. Ultimately, few of these studies account for patient preference, and none of these methods can be used completely independently of an overall package of care.

2.8 Models of care and person centered care

Integrated care has been shown to be cost effective [54] and is defined as including 4 core components: self-management support, delivery system design, clinical information systems and decision support.

There is consensus that person-centred care and self-management support are essential evidence-based components of good diabetes care [55] resulting in better quality of life, improved outcomes and fewer diabetes-related complications [56]. Nutrition management has shifted from a didactic and prescriptive 'one-size fits all' approach to a person-centred approach. A person-centred approach puts the person at the centre of their care and involves assessing the person's willingness and readiness to change, tailoring recommendations to their personal preferences and joint decision-making [14]. Training in patient-centeredness and cultural competence may improve communication and patient satisfaction, however, more research is needed to

ascertain whether this training makes a significant difference to healthcare use or outcomes [57, 58].

2.9 Use of behavioural approaches and motivational interviewing

The impact of behavioural approaches has been small, with motivational interviewing programmes showing very little impact on glycaemic control [59, 60]. However, the use of behavioural techniques appears to have more impact over other methods in people with Type 2 diabetes of greater duration and with higher HbA1c [61].

Signposts:

- National Institute for Health and Care Excellence. Diabetes in adults. Quality standard [QS6]. NICE: London; 2016
- Department of Health and Diabetes UK. Structured patient education in diabetes: report from the patient education working group. DOH & Diabetes UK: London; 2005.

3 Prevention of Type 2 diabetes

RECOMMENDATIONS

- Nutrition management is recommended as part of an integrated package of education and clinical care for all people with diabetes and those at risk of developing Type 2 diabetes.
- Aim for weight loss of at least 5%, where appropriate, to reduce the risk of Type 2 diabetes in high risk groups.
- Key recommendations for lifestyle interventions to reduce risk of Type 2 diabetes in high risk groups include:
    - Restrict energy intake
    - Reduce total and saturated fat intake
    - Increase fibre intake
    - Increase physical activity.
- Dietary patterns associated with reduced risk in general populations include:
    - Mediterranean diet
    - DASH diet
    - Vegetarian and vegan diets
    - The Nordic healthy diet
    - Moderate carbohydrate restriction.
- Include more specific foods associated with reduced risk in general populations such as wholegrains, some fruit, green leafy vegetables, yogurt and cheese, tea and coffee.
- Reduce specific foods associated with increased risk in general populations including red and processed meat, potatoes, particularly French fries, sugar sweetened beverages and refined carbohydrates.
- Offer culturally tailored, multi-component lifestyle interventions to reduce the risk of Type 2 diabetes in ethnic minority groups.

There is now strong evidence from RCTs that intensive multicomponent lifestyle interventions incorporating diet and physical activity with sustained weight loss can prevent Type 2 diabetes in high-risk individuals from different ethnic backgrounds [62-66]. The risk of Type 2 diabetes is reduced by approximately 50% after implementation of lifestyle interventions [67], and there is some evidence of a legacy effect, with three trials reporting lower incidence of Type 2 diabetes at 7–23 years follow-up beyond the active intervention period [68-70].

3.1 Components of lifestyle interventions

3.1.1 Weight loss

The most dominant predictor for Type 2 diabetes prevention is weight loss, and it has been demonstrated that weight losses of 5–7% reduce the relative risk of Type 2 diabetes by 50% [71]. In the European Diabetes Prevention Study (EDIPS), weight loss of 5% maintained at 3 years follow-up reduced the risk of Type 2 diabetes by 89% [72]. Every kilogram lost is associated with a 16% relative reduction in risk [73], and losses of 10% may be sufficient to reduce the risk of future Type 2 diabetes by 80% [74]. Most trials of lifestyle interventions to prevent Type 2 diabetes use a combination of diet and physical activity and do not distinguish the individual contributions of each component, and there is no evidence from head-to-head trials comparisons of different dietary strategies to support an optimum diet for weight reduction in people with impaired glucose tolerance at risk of Type 2 diabetes. Meta-analyses of RCTs in overweight individuals reported that a variety of diets were effective for weight loss, and differences between individual diets were small [75, 76].

3.1.2 Dietary strategies

The major RCTs used largely similar dietary approaches, often characterised as the 'prudent diet'/ 'healthy eating pattern', with the following components [71]:

- Energy restriction to induce 5–7% weight loss
- Dietary modification including:
- Moderate total fat intake (<35% total energy intake)
- Reduced saturated intake (<10% total energy intake)
- Increased dietary fibre intake (>15g/1000kcal)
- Increased physical activity, aiming for at least 30 mins/day or 150 mins/week of moderate to vigorous activity

This dietary strategy for weight loss and diabetes prevention is promoted by all major diabetes organisations [77-79], but it is likely that there are a variety of dietary strategies that are effective for weight loss and diabetes prevention, and this presents the opportunity to increase flexibility in dietary approaches for people at risk of Type 2 diabetes [12].

3.2 Dietary patterns and specific foods

Few RCTs investigating the effects of dietary patterns and specific foods on the risk of Type 2 diabetes are available, given the time scale needed for follow up. It is impossible to continue to follow up study participants for many decades when the outcome of interest is far in the future, as is the case for diabetes. Well-conducted prospective cohort studies offer the best data for estimating rates of diabetes in exposed and unexposed individuals over long periods, and evidence from these studies suggests that there are components of the diet that may protect against Type 2 diabetes, or increase its risk, or may be neutral factors.

Evidence from prospective cohort studies indicate that diets with high fat, high glycaemic index (GI), and low fibre dietary patterns are associated with an increased diabetes risk [80]. Conversely, plant-based diets were associated with reduced risk of diabetes [81] and increased healthy eating scores over 4 years also reduced the risk of diabetes [82]. Dietary patterns associated with a reduced risk of Type 2 diabetes

include the Mediterranean diet [83-85], the Dietary Approaches to Stop Hypertension (DASH) diet [86], vegetarian and vegan diets [87], the Nordic healthy diet [88] and moderate carbohydrate restriction [89].
Foods that have been identified as being inversely associated with Type 2 diabetes incidence (and hence considered protective) include wholegrain products [90, 91], total fruit and vegetable intake [92], some specific fruits, especially blueberries, grapes and apples [93], green leafy vegetables [92, 94], fermented dairy products such as yogurt and cheese [95, 96] and coffee and tea [97, 98]. Some foods appear to have little or no association with Type 2 diabetes incidence and these include eggs [99], nuts [100, 101] and fish, although marine n-3 polyunsaturated fatty acids (PUFA) may have beneficial effects in Asian populations [102, 103]. Foods that appear to be associated with an increased risk of Type 2 diabetes include red and processed meat [104-106], potatoes, particularly French fries [107, 108], sugar sweetened beverages [109] and refined carbohydrates [110]. Alcohol displays a U-shaped association with Type 2 diabetes [111].
In summary, diets that may protect against Type 2 diabetes are characterised by high intakes of wholegrains, fruit, vegetables, yogurt, cheese, coffee and tea and which are lower in red and processed meat, refined carbohydrates and sugar-sweetened beverages.
There are also specific vitamins and minerals that have been associated with a lower incidence of Type 2 diabetes. Epidemiological evidence suggests that higher intakes of magnesium may reduce risk [112], but zinc and chromium do not have any clear effect [113, 114]. Prospective cohort studies have demonstrated an inverse association between serum 25-hydroxyvitamin D and incidence of diabetes [115], but intervention trials have failed to show significant effects of supplementation on the incidence of Type 2 diabetes [116]. However, prior trials had some limitations including the use of adequate dose of supplementation, and further results from ongoing trials are anticipated to clarify the role of vitamin D in the prevention of Type 2 diabetes [117].

3.3 Translating RCTs to the real world

One of the most challenging aspects of Type 2 diabetes prevention remains the general application of positive results from clinical trials to the real world and key challenges include scaling up, appropriate intervention selection and demonstrating clinically meaningful, cost-effective solutions [118]. There is evidence that intensive multicomponent lifestyle interventions are effective in decreasing Type 2 diabetes incidence, but it is challenging to identify the most effective features of prevention programmes and the majority of initiatives report short-term outcomes, frequently reporting weight loss rather than Type 2 diabetes incidence [119]. There is evidence of attenuation of effect, with real world studies reporting mean weight losses of 2.2%, compared with those of 5–7% reported in RCTs [120].

3.4 Physical activity

Evidence from RCTs and prospective cohort studies report an inverse relationship between physical activity and/or exercise and risk of Type 2 diabetes [121, 122], with studies reporting a 25–40% reduction in the relative risk of diabetes associated with increased physical activity or exercise [121]. Strategies incorporating diet, physical activity and exercise, or a combination of these, have been adopted in prevention trials but there is insufficient evidence to support one approach over another [123]. There is evidence that, even in the absence of weight loss, increased physical activity and

exercise can reduce the incidence of Type 2 diabetes, although it is challenging to differentiate between the effects of activity and weight loss as those who move more tend to lose more weight over the intervention period [124]. There is also evidence of an additive effect of obesity combined with low levels of physical activity or exercise; with about seven-fold increased risk compared to those of normal weight and with high physical activity or exercise levels [125]. In addition, recent research indicates that sedentary behaviour increases the risk of Type 2 diabetes, and that this effect is independent of time spent being physically active or exercising [126].

The evidence supports current recommendations for levels of physical activity and exercise to prevent Type 2 diabetes; namely 30 mins/day or 150 mins/week of moderate to vigorous activity [124]. All types of moderate to vigorous activity, including walking, occupational activity, leisure activity and resistance exercise were associated with reduced risk of Type 2 diabetes [121, 122].

4 Weight management and remission of Type 2 diabetes

RECOMMENDATIONS

- For overweight or obese people with Type 2 diabetes;
  - For Type 2 diabetes remission, aim for weight loss of approximately 15kg, as soon as possible after diagnosis.
  - To improve glycaemic control and CVD risk, aim for at least 5% weight loss achieved by reducing calorie (energy) intake and increasing energy expenditure.
- Adopt an individualised approach which may include dietary, physical activity, surgical and medical strategies that are recommended for people without diabetes.

For overweight or obese adults with Type 2 diabetes, reducing energy intake to achieve weight loss should be the primary nutritional management strategy. While the evidence relating to mortality and cardiovascular event rates is equivocal [127, 128], early results from a recent RCT suggest that Type 2 diabetes remission can occur with significant weight loss of about 15kg [129]. Weight loss of 5% or more significantly improves HbA1c, total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides, blood pressure and insulin sensitivity, with effects of weight loss on glycaemic control or remission most pronounced earlier in the disease process [130, 131].
Uncertainties remain over the most effective dietary intervention to promote successful weight loss [132] and gold standard RCTs that compare dietary interventions head-to-head over extended time periods are limited. Studies investigating the effect of weight loss in Type 2 diabetes have utilised multicomponent intensive lifestyle interventions, diets with varied macronutrient composition including low fat diets, low carbohydrate diets, Mediterranean diets, very low energy diets (VLED), total diet replacement (TDR), meal replacement plans, commercial programmes and increased physical activity.

4.1 Intensive multicomponent lifestyle interventions

Intensive multicomponent lifestyle interventions are effective for weight loss in Type 2 diabetes [130, 133, 134]. A recent large intensive intervention in the United States (the Look AHEAD Study), which included a low-fat diet, meal replacements and exercise, significantly reduced body weight with weight loss of ≥5% or more maintained at 8 years in over 50% of participants [135]. Cardiovascular risk factors and HbA1c also improved significantly and the approach has been adapted for use in a usual care setting in the U.S. with promising results [23]. Achieving weight loss early in such interventions is associated with better long-term weight maintenance [136].

4.2 Diets

4.2.1 Diets with variable macronutrient composition

Systematic reviews and meta-analyses of RCTs, and individual RCTs lasting 6 months or more generally report non-significant or marginal differences in weight loss across a

range of approaches including low-fat, low-carbohydrate, high-protein and high monounsaturated fat (MUFA) diets, in adults with Type 2 diabetes [130, 137-141]. Evidence suggests that it is the degree of adherence that predicts outcomes rather than type of dietary strategy [142, 75]. It is intuitive that a diet an individual can continue to follow is more likely to succeed, and this was confirmed in a network meta-analysis of RCTs of weight loss comparing different dietary compositions [75].

Low fat diets are historically the most widely employed in research studies and have generated a significant evidence base for effectiveness for weight loss in Type 2 diabetes [130, 135].

Low-carbohydrate diets have created some controversy, but overall evidence suggests that they are safe and effective over the short term for weight loss. Concern has been expressed about the potential adverse effects of these diets, especially on cardiovascular risk; while there remains no evidence of harm over the short term, long-term side effects remain unknown [138, 143, 144]. It has been shown that the main mode of action of low carbohydrate diets is likely to be an accompanying reduction in energy intake associated with carbohydrate restriction [145]. The Scientific Advisory Committee on Nutrition (SACN) is currently investigating the role of low carbohydrate diets in people with Type 2 diabetes and is due to report in 2020 (see signpost).

Recent systematic reviews of RCTs have found that a Mediterranean style diet (typically high MUFA) is also an effective approach for achieving weight loss in Type 2 diabetes [137, 146, 147].

Ongoing inconsistency with definitions of ‘low’ and ‘high’ macronutrient diets, inadequate reporting of actual versus prescribed intake and high heterogeneity in meta-analyses remain a challenge when interpreting such studies.

4.2.2 Very low energy diets (VLED)

Systematic reviews of RCTs suggest that VLEDs are effective for weight loss in Type 2 diabetes and result in greater weight loss at 3-6 months compared to standard care [148-150].

NICE no longer recommends routine use of VLED, and suggests that these diets should be used for a maximum of 12 weeks continuously or intermittently with a low energy diet, as part of multicomponent weight management strategies with clinical support [151, 152].

4.2.3 Total Diet Replacement (TDR)/ Meal replacement plans

There is good evidence that approaches where food is replaced by nutritionally complete liquid formulae, providing 800-1200kcals per day, either exclusively for a period of approximately 12 weeks (Total Diet Replacement – TDR) or partially (meal replacement plans) are effective for weight loss in Type 2 diabetes. Studies using TDR have reported mean weight losses of about 15kg and remission of Type 2 diabetes [129, 153, 154]. In the largest of these, with a structured strategy for food re-introduction and long term weight maintenance, 46% of participants lost sufficient weight to achieve diabetes remission [129].

Meta-analyses of RCTs report that meal replacement plans produce greater weight loss than a reduced energy diet over the short term (six months) [155]. This approach was further supported by a recent RCT in adults with Type 2 diabetes in Japan [156], and also improved weight loss outcomes when used as part of a multicomponent dietary strategy in the Look AHEAD trial [157]. A significant limitation of translating these

studies was provision of meal replacement products free of charge as part of interventions.

4.2.4 Commercial diet services

There is limited published evidence for commercial weight loss services specifically in people with Type 2 diabetes. A single RCT from the US comparing Weight Watchers programme (provided free-of-charge and augmented with counselling from a certified diabetes educator) to counselling alone, has shown significantly better weight loss, HbA1c and less need for diabetes medications [158].

4.3 Physical activity

Physical activity or exercise in isolation are not effective strategies for weight loss in people with Type 2 diabetes [159] unless 60 minutes per day is undertaken [160]. Evidence is conflicting as to whether a combination of diet and physical activity or exercise results in greater weight reduction than diet or activity alone [133, 160]. Independent of weight management, physical activity and exercise have numerous health benefits in Type 2 diabetes including improving blood glucose control, cardiovascular risk factors and well-being [124].

4.4 Bariatric surgery

Bariatric (or metabolic) surgery is recommended as a treatment option in adults with Type 2 diabetes with a BMI of 30kg/m^2 or greater [152, 161]. It has been shown to be more effective than conventional medical therapy alone for weight loss, glycaemia and cardiovascular risk factor improvements [161-164].

Type 2 diabetes remission is reported to occur in 30–62% of patients following surgery. An RCT of adjustable gastric banding for obese patients with Type 2 diabetes found that remissions occurred in over 80% of patients who lost over 15kg [165]. Late weight regain is usual after all bariatric surgery, and available data suggests an erosion of remission over time, with 35–50% or more eventually experiencing relapse, with greater durability of remission associated with shorter diabetes duration prior to surgery [161, 166]. Consequently, patients need monitoring of glycaemia immediately post-op and in the longer term to allow appropriate adjustment of diabetes treatment regimens as necessary.

Common nutritional deficiencies include protein malnutrition, iron, calcium, Vitamin D and Vitamin B12. Regular dietetic support is recommended both pre- and post-surgery to provide information on the appropriate diet for the bariatric procedure and to attenuate the risks of dumping syndrome and nutritional deficiencies [152, 167]. Supplementation is recommended depending on the surgical procedure [168]. Comprehensive guidelines on nutritional management of bariatric surgery have been produced by The British Obesity and Metabolic Surgery Society [169].

4.5 Other approaches:

To date, RCTs do not show better weight loss with intermittent fasting or mindful eating compared to other approaches in Type 2 diabetes, but overall evidence is sparse and further research is warranted [170, 171].

Signposts:

- National Institute for Health and Care Excellence (2014). Obesity: Identification, Assessment and Management of Overweight and Obesity in

Children, Young People and Adults: Partial Update of CG43. London: National Clinical Guideline Centre, 2014.
- British obesity and metabolic surgery society (BMSS). Available at: http://www.bomss.org.uk/
- Top ten tips for post bariatric patients in primary care. Available at www.rcgp.org.uk
- Scientific Advisory Committee on Nutrition (SACN). Lower carbohydrate diets for adults with type 2 diabetes. Available at: https://www.gov.uk/government/groups/scientific-advisory-committee-on-nutrition

5 Glycaemic control and Type 1 diabetes

RECOMMENDATIONS

- Offer education to support people with Type 1 diabetes to identify and quantify their dietary carbohydrate intake for glycaemic control. Specifically:
  - Adjust insulin to carbohydrate intake in people using multiple daily injections (MDI) and continuous subcutaneous insulin infusion (CSII) (insulin pump).
  - Aim for consistent quantities of carbohydrates on a day-to-day basis in people on fixed insulin regimens.

5.1 Carbohydrate

The amount and type of carbohydrate is the main nutritional consideration for people with Type 1 diabetes in terms of glycaemic control, and both the amount and type have an effect on post-prandial blood glucose levels.

5.1.1 Amount of carbohydrate

There is no convincing evidence for a recommended ideal amount of carbohydrate for maintaining long-term glycaemic control in people with Type 1 diabetes, and intervention studies have failed to show any significant effect on glycaemic control of manipulating quantity of carbohydrate [172-175]. There are no long-term RCTs investigating the efficacy of low carbohydrate diets in people with Type 1 diabetes, although a small pilot study has highlighted the potential for robust research into the efficacy, safety and practical application of low carbohydrate diets in Type 1 diabetes [176].

On a meal-by-meal basis, matching insulin to the amount of carbohydrate consumed (carbohydrate counting and insulin dose adjustment) is an effective strategy for improving glycaemic control. Randomised controlled trials in adults with Type 1 diabetes have shown carbohydrate counting can improve glycaemic control, quality of life and general well-being without increases in severe hypoglycaemic events, body weight or blood lipids [18, 177-179]. Carbohydrate counting and insulin adjustment have proven to be efficacious and cost effective in the long term [30]. In addition, dietary freedom associated with these regimes does not seem to be associated with significant deterioration in eating habits or increased dietary intake [180, 181]. These strategies can only be utilised by individuals treated by MDI or CSII, where prandial insulin doses can be manipulated according to carbohydrate intake. For individuals on fixed or biphasic insulin regimens, consistency in the quantity of carbohydrate and glycaemic index (GI) on a day-to-day basis are all beneficial and have been positively associated with improved HbA1c levels [182].

5.1.2 Type of carbohydrate

The amount of carbohydrate ingested is the primary determinant of post-prandial blood glucose response, but the type of carbohydrate also affects this response. Studies have investigated the effects of glycaemic index, dietary fibre and sugar on glycaemic control.

5.1.3 Glycaemic index (GI)

A Cochrane review reported reductions of 6mmol/mol (0.5%), on average, in HbA1c in people with diabetes adopting a low GI diet, but of the 11 studies included, only one related specifically to adults with Type 1 diabetes [183]. Observational studies have reported that dietary GI is independently associated with HbA1c, with intakes of high GI foods showing an association with higher HbA1c levels [184]. Some small studies have observed that post prandial glucose levels can be up to 20% lower when a low GI meal is consumed [185], with variables such as dietary fat [186] and protein intake [187] also having some impact on post prandial blood glucose. However, it should be noted that other variables such as basal insulin and frequency of self-monitoring of blood glucose (SMBG) are more predictive of overall long term glucose control [188]. The current NICE guidance for Type 1 diabetes does not recommend low GI diets for blood glucose control (see signpost).

5.1.4 Dietary fibre

The effect of dietary fibre on glycaemic control in Type 1 diabetes is unclear. Observational studies suggest that dietary fibre (of any type) is associated with lower HbA1c levels [189], with an additional benefit of reduced risk of severe ketoacidosis [190]. There is little evidence from RCTs; all studies in people with Type 1 diabetes are small, short-term and involve daily fibre intakes double that of the recommended amounts for the general population. Longer-term (more than six months) studies investigating the benefits of a high fibre intake are scarce [191].

High fibre intakes may be beneficial for those with Type 1 diabetes, but the first priority may be to encourage achievement of the current UK recommendation of fibre consumption of 30g per day [7].

5.1.5 Sugars and other sweeteners

Signpost: See pages 60 – 62: Commercial diabetic foods, sugars and other sweeteners.

5.2 Protein and fat

There is insufficient evidence to suggest the routine assessment of protein as a means to control postprandial blood glucose levels, although evidence from small intervention studies suggests protein intake increases postprandial glucose levels [187, 192]. Other small studies have also suggested that high intakes of fat delay immediate postprandial hyperglycaemia and cause sustained late postprandial hyperglycaemia [187, 193]. However, considering the strength of the current evidence, and the magnitude of the effect of fat and protein on postprandial blood glucose, more evidence is needed to justify routine prioritisation of fat and protein counting in clinical practice.

5.3 Alcohol

Alcohol in moderate amounts can be enjoyed safely by most people with Type 1 diabetes, and it is recommended that general advice about safe alcohol intake (14 units or less per week) be applied to people with diabetes, with some caveats (see signposts).

Studies have reported that a moderate intake of alcohol is associated with improved glycaemic control in people with diabetes [194], although alcohol is also associated with an increased risk of hypoglycaemia in those treated with insulin [195].

Hypoglycaemia is a well-documented side-effect of alcohol in people with Type 1 diabetes [196], and can occur with relatively low levels of alcohol intake and up to 12 hours after ingestion [197, 198]. There is no evidence for the most effective treatment to prevent alcohol-related hypoglycaemia, but pragmatic advice includes recommending insulin dose adjustment, additional carbohydrate or a combination of the two according to individual need.
There are some medical conditions where alcohol is contraindicated and they include hypertension, hypertriglyceridaemia, some neuropathies, retinopathy and during pregnancy (see signpost).

5.4 Body weight

Higher BMI is associated with macrovascular complications and retinopathy in Type 1 diabetes [199].
There is no published evidence from RCTs showing a direct relationship between body weight and glycaemic control in people with Type 1 diabetes, although it should be noted that a high HbA1c may be associated with long term hyperglycaemia which causes weight loss [200, 201]. There is no existing published evidence from RCTs showing that weight management in itself appears to impact glycaemic control in people with Type 1 diabetes.
The metabolic benefits of bariatric surgery in obese people with Type 1 diabetes have been investigated and two meta-analyses have shown that bariatric surgery in obese people with Type 1 diabetes leads to a significant though modest reduction in HbA1c of 7 – 9mmol/mol (0.64 - 0.79%) [202, 203]. However, a recent study has shown that although surgery-induced weight loss was similar among obese people with Type 1 and Type 2 diabetes, those with Type 2 diabetes achieved significantly greater reduction in HbA1c at 12 months follow-up [204].
Independent of glycaemic control, given the increasing prevalence of overweight and obesity in the general population, current NICE guidance recommends offering weight management dietary advice to adults with Type 1 diabetes if clinically indicated [205].

5.5 Physical activity

The overall health benefits of physical activity and exercise in people with Type 1 diabetes are not well documented. However, there is evidence from meta-analyses of RCTs of improved cardiorespiratory fitness [206, 207] accompanied by reductions in both cardiovascular disease (CVD) and mortality [208]. Physical activity and exercise are not strongly associated with better glycaemic outcomes [206-209] and although activity may reduce blood glucose levels it is also associated with increased hypo and hyperglycaemia [206]. On a day-to-day basis, physical activity and exercise can lead to hyperglycaemia or hypoglycaemia dependent on the timing, type and quantity of insulin, carbohydrate and physical activity [209].
Therapeutic regimens should be adjusted to allow safe participation in physical activity or exercise. Activity should not be seen as a treatment for controlling glucose levels, but instead as another variable which requires careful monitoring to guide the adjustment of insulin therapy and/or carbohydrate intake. For planned exercise, reduction in insulin is the preferred method to prevent hypoglycaemia while additional carbohydrate may be needed for unplanned activity [210].

Signposts:

- National Institute for Health and Care Excellence. Type 1 diabetes in adults: diagnosis and management [NG 17]. London, NICE; 2015.
- www.nhs.uk/Livewell/alcohol
- http://www.nhs.uk/Conditions/Blood-pressure-(high)/Pages/Treatment.aspx
- http://www.nhs.uk/news/2008/03March/Pages/Pregnancydrinkinglimits.aspx

6 Glycaemic control and Type 2 diabetes

RECOMMENDATIONS

- Prioritise sustained weight loss of at least 5% in overweight people by reducing calorie (energy) intake and increasing energy expenditure.
- Aim for a Mediterranean-style diet or equivalent healthy eating pattern. (See CVD section).
- Offer individualised education to support people to identify and quantify their dietary carbohydrate intake, encourage low glycaemic index (GI) foods and consider reducing the total amount of carbohydrates.
- Aim for at least 150 mins per week of moderate to vigorous physical activity, over at least three days.

6.1 Weight management

Between 80 and 90% of people with Type 2 diabetes are overweight [211-213] and/or have excess fat accumulation compromising liver and pancreatic function [214]. Weight loss can reverse the metabolic abnormalities seen with Type 2 diabetes and should be the primary management strategy [127, 130, 215]. A recent meta-analysis of RCTs concluded that weight loss of ≥5% is necessary to improve glycaemic control significantly, showing a 7mmol/mol (0.6%) reduction in HbA1c in established Type 2 diabetes and up to 13mmol/mol (1.2%) in a newly diagnosed study group [130]. Longitudinal cohort studies have also indicated that change in BMI is a significant predictor of change in HbA1c, and that people with Type 2 diabetes who lose weight are more likely to achieve HbA1c targets than those with stable weight or weight gain [131].

More intensive weight management can achieve remission of Type 2 diabetes for 11% of people who achieve 8% weight loss [216], for 73% of people with weight loss of greater than 10kg, and for 86% of those with weight loss >15kg [129, 165]. Sustained remissions have been reported after bariatric surgery [217] but there remains a major challenge to maintain weight loss after non-surgical interventions.

Weight loss can also be a result of poor glycaemic control; the relationship between blood glucose and weight is not always straightforward. Weight gain is positively associated with insulin resistance and therefore weight loss improves insulin sensitivity and features of the metabolic syndrome and reduces cardiovascular risk [215]. Intensification of therapy is often associated with weight gain. Sulphonlyurea and glitazone therapies are associated with mean weight gain of 2–3kg [218] and initiation of insulin therapy in Type 2 diabetes is associated with a mean weight gain of approximately 2kg over a year, however one quarter of people gain at least 5kg [219].

(See section 4 ‘Weight management’).

6.2 Diet

6.2.1 Dietary patterns

Evidence is limited for the superiority of a single dietary approach in the long-term management of hyperglycaemia in Type 2 diabetes, suggesting that a range of diets may be suitable [137, 220]. The choice of diet should therefore be based on several

factors including the overall nutritional quality of the diet, patient preference and acceptability of the diet, the evidence for potential clinical benefits and any risk of harm.

6.2.1.1 Mediterranean diet

Meta-analyses of RCTs report that the Mediterranean diet can lower HbA1c by up to 5mmol/mol (0.47%) more than standard care or a low fat diet [84]. One RCT demonstrated that the Mediterranean diet in people newly-diagnosed with Type 2 diabetes delayed the need for diabetes medication [146]. The Mediterranean diet may not be suitable for all cultures and equivalent healthful eating patterns have been developed e.g. New Nordic diet, but there is little evidence for the role of these strategies in improving glycaemic control.

6.2.2 Dietary approaches focusing on macronutrients

The ideal proportion of macronutrients to recommend for optimal glycaemic control for Type 2 diabetes is unclear, but total energy intake, weight loss and overall diet quality are significant factors. Small, short term intervention studies investigating the relationship between macronutrients and glycaemic control have reported contradictory results [14]. Observational studies examining the relationship between nutrient intake and glycaemic control or risk of diabetes complications have also reported mixed results. For example, a large prospective cohort study reported no clinically significant differences in HbA1c with either a low-fibre, high added-sugar diet or lower fat and higher carbohydrate intakes [221]. The proportion of energy from carbohydrate was not associated with the risk of any diabetes complication across a period of 8 years follow-up in a Japanese study [222]. Intervention studies have failed to show any association between the type and amount of fat in meals and post-prandial glucose response [223-227].

From this evidence, there is no reason to recommend any specific ideal proportion of macronutrients specifically for optimal glycaemic control for Type 2 diabetes. However, total energy intake, overall diet composition and controlled total energy intake for weight management is vital. The overall diet quality also has significant impact on diabetes complications (see CVD section).

6.2.2.1 Low carbohydrate diet

Given that carbohydrate content of the diet is the prime determinant of glycaemia, there has been great interest in using low-carbohydrate diets for the management of Type 2 diabetes. However, evidence thus far is limited with inconsistent findings, lack of studies of longer term effects, and lack of clarity on what constitutes the definition of low carbohydrate [143], with some promoting modest reductions in carbohydrate intake and others recommending very low-carbohydrate, ketogenic diets. Some evidence reviews have not been systematic and reported mixed results [228, 229] with some meta-analyses of RCTs reporting clinically modest, but statistically significant reductions in HbA1c of 3-4mmol/mol (0.3-0.4%) in short-term studies [138, 230] but no difference at 12 months and beyond [138]. Adherence to either the low or high carbohydrate arms of the studies is generally poor [143]. A recent study with good adherence found similar reductions in weight and HbA1c in both the low carbohydrate and high carbohydrate groups, but a greater reduction in diabetes medication was seen in the low carbohydrate group [231]. There are no studies that report the efficacy or safety of very low carbohydrate ketogenic diets over the long-term in people with Type 2 diabetes.

6.2.2.2 High-fibre diet

Dietary fibre, both soluble and insoluble, has many health benefits [232], but the impact on hyperglycaemia is limited. Post-prandial glucose levels have been shown to be reduced on high fibre diets (>20g /1,000 kcal) and a meta-analysis suggests a modest reduction of HbA1c of 3mmol/mol (0.26%) with additional amounts of fibre ranging from 4–40g per day. However many of the included studies used fibre supplements [233]. Observational data shows higher intakes of dietary fibre are associated with lower values for HbA1c [234, 235].

There is considerable interest in the role of gut microbiome in obesity, insulin sensitivity, glucose metabolism and diabetes [236, 237]. Adherence to a plant-based Mediterranean diet has been associated with beneficial gut microbiome-related profiles [238, 239], and short-chain fatty acids (SCFAs) generated from intestinal bacterial fermentation of dietary fibre has been shown to play a role in energy metabolism [237]. However, more evidence from human studies is needed to understand the specific role of dietary approaches in altering gut microbiome and its effect on diabetes management, and prevention of Type 2 diabetes [236].

6.2.2.3 Low glycaemic index diet

Replacing high GI foods with low GI foods in the diet confers a clinically small but statistically significant benefit for glycaemic control. Low GI diets have shown improvements in HbA1c of between 4 and 6mmol/mol (0.4–0.5%) [240, 241], although the results may be confounded by differences in fibre content and weight change between low and high GI diets. Notably, two large RCTs showed no difference in HbA1c between a low GI diet and a standard diet [242, 243].

6.2.2.4 Carbohydrate counting

The efficacy of carbohydrate counting in people with Type 2 diabetes treated with insulin is largely unknown. Carbohydrate counting based on insulin to carbohydrate ratio has been shown to be as effective in reducing HbA1c as a simple algorithm based on self-monitored blood glucose (SMBG) [244]. Carbohydrate counting has limited application in people with Type 2 diabetes treated by regimens other than basal bolus insulin. However, monitoring carbohydrate intake whether by use of exchanges, portions or experience-based estimation remains a key strategy in achieving glycaemic control in people with Type 2 diabetes [245].

6.2.2.5 Sugars and sweeteners

Signpost: See pages 60-62: Commercial diabetic foods, sugars and other sweeteners.

6.3 Physical activity

Physical activity and exercise have clear benefits for cardiovascular risk reduction and improving glycaemic control in people with Type 2 diabetes, with systematic reviews of RCTs reporting reductions in HbA1c of between 5mmol/mol (0.45%) [246] and 8mmol/mol (0.74%) [247], and individual RCTs demonstrating up to 16mmol/mol (1.5%) reduction in HbA1c [248]. Aerobic and resistance exercise both demonstrate benefits for glycaemic control [249], however incorporating both forms may confer even greater benefits [250]. Higher-intensity forms of exercise offer additional reductions in HbA1c over lower-intensity exercise and, although the difference is small [250, 251] it

may allow for similar reductions with fewer exercise sessions [249]. There is emerging evidence that interrupting prolonged sedentary behaviour by standing or walking improves post-prandial glucose control, although the long-term benefits are less well defined [252, 253]
Many studies do not report adverse events and those few that do often report events that are not related to diabetes [247]. It is safe for individuals with Type 2 diabetes who are treated by diet alone or in conjunction with oral hypoglycaemic agents to exercise in both the fasting and post-meal state [254], with the most beneficial effects on blood glucose levels observed post-prandially when blood glucose levels have more potential to reduce [255, 256]. For individuals treated with sulphonylureas or insulin, care should be taken to minimise the impact of hypoglycaemia which can occur up to 24 hours after physical activity [256].

Signposts:

- Diabetes UK position statement on low carb diets for people with diabetes. https://www.diabetes.org.uk/low-carbohydrate

7 Cardiovascular disease – blood lipids and blood pressure

RECOMMENDATIONS

- Dietary patterns, specifically the Mediterranean and DASH-style diets, are recommended to reduce CVD risk factors and CVD events in people with diabetes. Key features of these diets include:
  - decrease salt intake (<6g/day)
  - eat two portions of oily fish each week
  - eat more wholegrains, fruit and vegetables, fish, nuts and legumes (pulses)
  - eat less red and processed meat, refined carbohydrates and sugar sweetened beverages
  - replace saturated fats (SFA) with unsaturated fats, and limit intakes of trans fatty acids (TFA)
  - limit alcohol intake to <14 units a week.
- Aim for modest weight loss of at least 5% in overweight individuals.
- Aim for at least 150 mins per week of moderate to vigorous physical activity, over at least three days.
- Products containing 2-3g of plant stanols and sterols per day can be recommended.

Individuals with Type 1 and Type 2 diabetes have about twofold increased risk of developing a range of cardiovascular diseases (CVD) compared to those without diabetes [257] and as a result it is recommended that dietary recommendations for diabetes should reflect those for people with existing CVD. Dietary approaches resulting in a reduction in total and LDL cholesterol and improvements in blood pressure have been shown to improve CVD outcomes in people with and without diabetes [258, 259].
Specifically in people with Type 2 diabetes, two meta-analyses of RCTs concluded that intensive multicomponent lifestyle interventions showed significant benefit in reducing blood pressure, cholesterol and HbA1c [15, 16].

7.1 Fat intake

7.1.1 Total fat

The exact proportion of energy that should be derived from total fat intake does not appear to be critical. In people with diabetes, studies recommending up to 40% of energy from fat (mostly unsaturated fat) [84, 224] have resulted in beneficial effects on lipid profiles, blood pressure and weight, similar to approaches using less than 30% of energy from fat [260]. These findings suggest that any effects of fat on CVD risk factors are likely to be derived from the type of fat rather than the amount per se. The latest USA dietary guidelines, for instance, has de-emphasised total fat intake, and pointed

out the importance of the types of fat for CVD prevention [5]. However, most published data on the effect of different types of fats on CVD risk factors and CVD hard end points have involved people without diabetes. In the absence of specific studies involving people with diabetes, data have been extrapolated from studies in people without diabetes.

7.1.2 Saturated fat

There is strong evidence that reduction in saturated fat intake and replacement with unsaturated fat is effective in reducing the risk of CVD, based largely on the effects of saturated fat on raising LDL-cholesterol, and this advice forms the basis of current recommendations across Europe and the USA [77, 261-265].

Yet, this has not been without ongoing controversy [266, 267]. Reports of controversy about the role of saturated fat in promoting CVD have been largely based on reviews of prospective or trial evidence that considered a direct association between dietary saturated fat intake and coronary risk, without considering the replacement nutrient [268-270]. A Cochrane review of RCTs concluded that reduction in SFA could reduce cardiovascular events by 17%, though notably null findings were obtained for all-cause or CVD mortality, fatal or non-fatal myocardial infarction (MI) or stroke [271]. Crucially, replacing SFA with PUFA was beneficial but replacement with carbohydrates or MUFA did not show similar benefits. Diabetes UK and the Diabetes Specialist Group of the British Dietetic Association reviewed the evidence and issued a policy statement in 2015 (see signpost). This stated that reducing saturated fats was beneficial, and that replacing saturated fats with unsaturated fats and/or wholegrains decreased CVD risk, but replacing with refined carbohydrates increased CVD risk [272]. It further recommended that information about SFA was delivered in the context of foods that support good health.

Recent findings of the PURE study across 18 countries showed no harms associated with SFA but rather, higher risk with carbohydrate intake. However, this was a prospective study with its own set of limitations; nonetheless it provides one further example of the controversy about SFA and CVD, particularly in a global context [273]. Despite the ongoing controversy, until more definitive evidence emerges, the current Diabetes UK position is to recommend the lowering of dietary SFA, replacing it with PUFA intake and not with refined carbohydrate intake, for CVD prevention.

7.1.3 Polyunsaturated fat

As reviewed above, the current recommendation for CVD prevention is to replace dietary SFA with PUFA from sources such as from vegetable oils, fish and nuts, but this too has been controversial, particularly in the context of omega-6 rich vegetable oils. A meta-analysis of RCTs which investigated increased polyunsaturated fatty acid (PUFA) intakes found that advice to specifically increase n-6 PUFA, without also increasing n-3 PUFA, may increase the risk of coronary heart disease (CHD) and death [274]. A more recent Cochrane review has concluded that there is currently insufficient evidence from RCTs to recommend increasing or decreasing n-6 PUFA intake for the prevention of CVD [275]. A review of the beneficial role of PUFA in coronary prevention was undertaken as part of the American Heart Association (AHA) Presidential Advisory on dietary fats, and is not further reviewed here [265].

7.1.4 Oily fish and n-3 fatty acids

High intakes of oily fish, rich in n-3 unsaturated fats, are associated with reduction in total mortality and, CHD [276, 277], and interventions post-MI show reduced mortality in those consuming oily fish at least twice a week [278].

In terms of fish oil supplementation, there is conflicting evidence and concerns about the potential adverse effect on lipid profiles, but there is some evidence of the beneficial effects for those with elevated blood triglycerides [279, 280]. Evidence for hard end points has been conflicting. A meta-analysis of 14 RCTs showed that in people with CHD, supplementation with n-3 reduced the risk of death from all causes, but was not associated with reducing risk of major CV events [281]. However, an earlier meta-analysis of 20 trials, that included mostly people with history of CV events, showed no benefit of n-3 supplementation on CVD [282]. Results of the ASCEND trial of fish oil (n-3 EPA and DHA) supplementation in people with Type 2 diabetes are currently awaited and should help to clarify the role of such supplementation in CVD prevention [283].

Plant sources of n-3, alpha-linolenic acid, have also shown to be associated with lower risk of CVD [284]. In people with diabetes, a prospective study concluded that high intakes of PUFA, especially alpha linolenic acid, protected against cardiac events [285].

7.1.5 Trans fatty acids

Recommendations for reduced intakes of trans-fatty acids (TFAs) should be in line with those for the general population. A recent meta-analysis of prospective studies has shown that total TFA intake was associated with increased all-cause mortality, CHD mortality and total CHD [268]. An earlier meta-analysis of observational and trial evidence reported a 20 – 32% higher risk of MI or CHD death for every 2% of dietary energy from TFA isocalorically replacing carbohydrate, SFA, MUFA and PUFA [286]. Ruminant TFA from dairy products do not show the same harmful associations seen with industrially manufactured TFAs [287].

7.2 Salt

Reductions in salt are generally effective in lowering blood pressure in both normotensive and hypertensive individuals [288, 289]. UK guidelines recommend the consumption of no more than 6g per day [290]. Studies suggest further benefits from lower levels (down to up-to 3g per day [291]. This would apply particularly to people with Type 2 diabetes who are at elevated risk of cardiovascular disease, but to achieve this goal would require major effort from individuals because salt is added to many manufactured foods. Significant action is needed from policymakers and the food industry to improve health by major reductions in salt [292].

7.3 Dietary patterns

7.3.1 Dietary Approaches to Stop Hypertension (DASH)

Systematic reviews and meta-analyses of RCTs have shown the beneficial effects of the DASH-type diet on both systolic and diastolic blood pressure, and that these effects seem greater in people with higher baseline blood pressure or BMI [293-295]. In people with Type 2 diabetes, the DASH diet has been shown to increase HDL and reduce LDL concentrations and reduce blood pressure [296]. A meta-analysis of observational prospective studies including people with diabetes concluded that the DASH diet significantly reduced CVD and CHD events, and reported a significant inverse linear association between consumption of DASH diet and all CVDs [297].

7.3.2 Mediterranean diet

The Mediterranean diet has been associated with lower total and CVD mortality in both the general population and people with diabetes [298-300]. Results from the PREDIMED randomised controlled trial including 7,447 participants of whom 3,614 people had Type 2 diabetes, have confirmed the beneficial effects of a Mediterranean diet supplemented with either extra virgin olive oil or with mixed nuts, compared with dietary advice to consume a low-fat diet [84, 301, 302].

This dietary approach has been shown to reduce total cholesterol and LDL concentrations and blood pressure [259]. In people with Type 2 diabetes, meta-analyses of RCTs of Mediterranean diets have reported greater reductions in HbA1c, total cholesterol and triglycerides, and an increase in HDL cholesterol compared to control diets such as low fat diets and low carbohydrate diets [84, 147].

The beneficial effects of Mediterranean diets have been attributed to the high MUFA content from olive oil and nuts. However, people who follow Mediterranean diets also have higher intake of dietary fibre, wholegrains, fruits and vegetables, a higher proportion of n-3 fatty acids and lower proportion of n-6 fatty acid [299]. The Mediterranean diet is also lower in saturated fats as red meat and processed meat are limited [147].

7.3.3 Other dietary approaches

Both low fat and low carbohydrate diets have also shown positive results in reducing CVD risk factors in people with Type 2 diabetes [143, 138, 259]. However, whereas a low fat diet failed to show significant reductions in actual CVD events and CVD mortality in people with Type 2 diabetes when compared with usual care in the Look AHEAD Study [303], there are no RCTs reporting the long term effects of low carbohydrate diets on CVD endpoints in people with diabetes.

7.5 Specific foods

The combined effects of the evidence from DASH and Mediterranean diets suggest that specific foods, such as fruit and vegetables, nuts, wholegrains, olive oil, legumes and fish are associated with cardio-protection [304-309] whereas intakes of salt, red and processed meat, refined carbohydrates and sugar-sweetened beverages (SSB) increase CVD risk [304, 310]. Eggs seem to have a neutral effect on CVD [311, 312], although a subgroup of people may be hypersensitive to the effect of cholesterol from eggs [313].

7.6 Dietary fibre

There are no specific recommendations for individuals with diabetes, but higher intakes, particularly of soluble fibre, may have beneficial effects on blood lipid profiles and reduced risk of CVD and CHD [233, 258, 306, 314-316]. Intakes of total fibre in line with current UK recommendations are suggested for those at high risk of CVD (see signpost).

7.7 Alcohol

Evidence suggests that more than 3–4 units (28g) alcohol per day increases blood pressure and that drinking outside of meals may increase hypertension [317, 318]. Low to moderate alcohol intake is associated with lower incidence of CVD [319] but a reduction in alcohol intake in hypertensive individuals has been shown to be effective in lowering blood pressure, especially if more than 3–4 units (28g) alcohol per day are

consumed [318]. In people with diabetes, a systematic review of prospective cohort studies reported that 2–5 units (16–40g) alcohol per day was associated with a lower incidence of diabetes-related CHD, with no impairment of glucose control [320]. Red wine intake may confer additional CV benefits to people with Type 2 diabetes who follow a Mediterranean diet [321]. The current UK recommendation of consuming no more than 14 units of alcohol a week, spread evenly over three days or more and with several days each week without alcohol, is suggested for people with diabetes (see signpost).

7.8 Plant sterol or stanol esters

These are recognised to be effective in significantly reducing total and LDL cholesterol, in people with or without diabetes [322, 323]. Reductions in LDL cholesterol are also seen in people already using cholesterol-lowering statin drugs [324]. Intakes of 2–3 grams per day of plant sterol or stanol esters are effective in lowering total and LDL cholesterol and may be recommended [323]. However, NICE does not recommend the use of plant sterol/stanol products for primary prevention of CVD in people with diabetes [264], partly due to the lack of evidence from hard CVD endpoints [261, 262].

7.9 Weight loss

Intentional weight loss plays an important role in reducing CVD risk factors. A significant loss of more than 5% of body weight has shown benefits for blood pressure and lipids in Type 2 diabetes; despite some weight regain [130, 325]. The magnitude of weight loss correlates strongly with reduction in CVD risk factors [326]. Evidence has also shown that weight loss induced by bariatric surgery reduced CVD risk factors, and reduced mortality [167, 217]. However, the evidence relating to intentional weight loss and CVD events is equivocal [127, 128].

7.10 Physical activity

Increased physical activity is associated with reductions in cardiovascular risk in both Type 1 and Type 2 diabetes [208, 326, 327]. The most recent recommendations suggest that most adults with diabetes should engage in 150 mins or more moderate- to vigorous intensity activity per week [124]. This should be spread over at least three days a week, with no more than two consecutive days without activity. Prolonged sedentary behaviours, such as sitting for long hours, should be discouraged [263, 124].

Signposts:

- British Dietetic Association and Diabetes UK (2015). Policy statement: Dietary fat consumption in the management of Type 2 diabetes. https://www.diabetes.org.uk/dietary-fat
- Scientific Advisory Committee on Nutrition (2015). Carbohydrates and Health. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/445503/SACN_Carbohydrates_and_Health.pdf
- Public Health England (2016). The Public Health Burden of Alcohol and the Effectiveness and Cost-Effectiveness of Alcohol Control Policies. An evidence review https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/583047/alcohol_public_health_burden_evidence_review.pdf

8 Considerations in ethnic minority groups

In the UK, as in many other countries, immigrant ethnic minority groups have a higher prevalence of diabetes (specifically Type 2 diabetes) than the general population [328]. These inequalities are attributed to a complex interplay of genetic, environmental, cultural and socio-economic factors [329]. Additionally, ethnic minority groups often face significant barriers to accessing healthcare because of linguistic and cultural differences, poor health literacy, low socio-economic position and their migrant status [330]. As a result, ethnic minority patients often have poor diabetes knowledge, worse glycaemic control and higher rates of diabetes complications compared with the general population [331].

While diet and lifestyle advice and self-management education programmes have been shown to be effective [332], and are generally considered as the cornerstone of diabetes care, there is evidence that these can be less successful in people from ethnic minority groups [333, 334]. This has been attributed to a lack of cultural knowledge and awareness amongst healthcare practitioners, and a failure to account for cultural beliefs and practices in generic education programmes [329]. Culturally tailored advice and education programmes that are respectful of and responsive to the health beliefs, practices, cultural and linguistic needs of diverse patients have been developed to overcome issues relating to healthcare access in ethnic minority groups, and have been shown to have positive health outcomes [335]. Furthermore, ensuring cultural competency of healthcare professionals, such that they understand and can address the customs, beliefs and values of people from different cultural backgrounds is proposed as a principal way to address ethnic inequalities in diabetes and its management [335].
There has been a wealth of qualitative research conducted with ethnic minority groups to understand the barriers and facilitators to self-management. For instance, themes that arise in South Asian communities have been systematically reviewed and summarised as [336]:

- Language and communication discordance with the healthcare provider is a significant barrier to receiving and understanding diabetes education.
- Inconsistent willingness to partake in self-management with preference for following their physician's guidance.
- Lack of culturally-specific details on South Asian foods within dietary advice.
- Social responsibilities to continue with a traditional diet, and misconceptions on the components of the diet for people with diabetes.
- Concern about lack of gender specific exercise facilities and fear of injury or worsening health with exercise.
- Lack of understanding about diabetes medication management, preference for folk and traditional remedies, and concerns about long term safety of diabetes medications.
- Facilitators included trust in care providers, use of culturally appropriate exercise and dietary advice and increasing family involvement.

In African Americans the following themes have been identified through systematic reviews of the evidence [337, 338]:

- Internal factors including fear associated with glucose monitoring, lack of self-control over dietary habits, memory failure, and perceived lack of personal control over diabetes were primarily described as barriers to self-management behaviours.
- Support from family, peers, and healthcare providers positively influence adherence behaviours by providing cues to action, direct assistance, reinforcement, and knowledge.

8.1 Prevention of Type 2 diabetes in ethnic minority groups

There is strong evidence from large RCTs that intensive multicomponent lifestyle interventions can prevent the development of Type 2 diabetes amongst Indian [65, 339] and Chinese [64] natives (in their own countries) with prediabetes.

Randomised, controlled trials of lifestyle interventions incorporating diet and physical activity to target weight loss in high-risk migrant populations have been shown to be efficacious in African-Americans [340], Chinese-Americans [341] and UK South Asians [342]. These trials focused on weight loss, rather than incident diabetes, therefore the prevention of diabetes is inferred or modelled rather than measured directly. Weight loss among ethnic minority groups is reported as particularly challenging. African-Americans participating in the Diabetes Prevention Programme and other weight loss trials achieved approximately half the magnitude of weight loss than that achieved by White-Americans [343, 344]. In a trial of UK South Asians it was reported that weight loss was relatively modest at a mean loss of 1.13kg in the intervention group that received 15 dietitian visits [342], whilst another trial failed to achieve significant results [345].

The deleterious effects of a 'Western' type diet compared to a traditional East Asian (e.g. Japanese, Chinese, and Korean) diet have been demonstrated amongst Asian-Americans in a small trial showing worsening insulin resistance associated with consumption of a 'Western' type diet, whilst a traditional diet induced weight loss and improved insulin sensitivity [346].

A low glycaemic index dietary intervention for the prevention of Type 2 diabetes in Malaysian women with previous gestational diabetes (GDM) demonstrated significant improvements in body weight, BMI, waist-to-hip ratio and 2-hr glucose in an oral glucose tolerance test (OGTT) compared with a general healthy eating intervention, but incident diabetes was not included as an outcome [347].

There is evidence from large-scale uncontrolled trials targeting diabetes prevention among African-American communities that delivery of diabetes prevention interventions through partnerships with churches and faith-based institutions is an effective means of targeting high-risk minority groups, who may be less likely to engage through healthcare settings. Such programmes have demonstrated significant improvements in weight, BMI, fasting glucose and healthy nutrition and activity behaviours [348, 349].

8.2 Management of Type 2 diabetes in ethnic minority groups

A Cochrane review reported significantly greater improvements in glycaemic control in individuals receiving culturally appropriate health education for Type 2 diabetes compared with conventional diabetes education or usual care, and these benefits are maintained at 6, 12 and 24 months [350, 329]. In addition to glycaemic control, there were improvements in diabetes knowledge and self-efficacy with culturally appropriate education but no differences in blood pressure, blood lipids or BMI. It is noteworthy that 26/33 trials included in the review were based in the USA, only four trials were

based in the UK, all of which focused on South Asian communities [351-54]. In a meta-regression analysis of RCTs to identify the characteristics associated with reductions in HbA1c, the following recommendations were made: face-to-face interventions are more effective than telecommunication; individual format is more effective than group format; cognitive reframing techniques are associated with better outcomes; inclusion of a peer educator produces significantly better effects than no peer educator. There were no statistically significant differences for total duration of intervention, duration of each session, total number of hours of intervention or its intensity [355].
The following evidence-based guidance for planning and cultural tailoring of health education interventions for ethnic minority groups have been published [356, 329]:
Use previous research, experience of working with the community and the community themselves to inform the design of the intervention.
A combination of both group and individual education sessions is likely to have the greatest effect in most ethnic minority groups.

- Consider participants' socio-economic status, health literacy and any other potential barriers to effective diabetes management when designing the intervention.
- Bilingual/bicultural professional educators or non-professional workers providing the education or in a supportive role is recommended, to provide support to participants, attendance at sessions and adherence to dietary and lifestyle advice. Delivery of intervention in preferred language, including all materials.
- Educational group sessions held at weekly intervals, followed by regular telephone calls for reinforcement are likely to result in the greatest improvement.
- When recruiting participants, more personal methods, such as referral through clinics or telephone calls, are likely to be most effective.
- A particular effort should be made to recruit individuals who are currently demonstrating poor diabetes self-management skills and poor glycaemic control.
- Interventions should be pilot tested to assess their effectiveness and allow participant feedback to be incorporated into the intervention.
- Teaching/counselling about dietary change by modifying ethnic foods and recipes.
- Teaching/counselling of activity change using culturally appropriate activities e.g. dancing and walking.
- Attendance by family member to elicit home-based support.
- Use of visual aids to tailor to low-literacy needs.

8.3 Managing fasting in Type 2 diabetes

The month of Ramadan, and other periods of fasting/abstinence from food and beverages, can put people with diabetes at increased risk of acute complications, including hypoglycaemia and hyperglycaemia. Structured education programmes providing advice relating to diet, activity and medication management during fasting have been shown to reduce the risks of acute complications and to lessen weight gain [357, 358]. The 'READ' RCT, delivered 2 hours of structured education, to UK Muslims two to four weeks before Ramadan, by multilingual healthcare professionals in conjunction with community link workers and showed significant and sustained benefits

on glycaemic control for at least 12 months, and reduction in risk of complications [357].

Signposts:

- For practical information about cultural foods and dietary behaviours further reading is recommended:
- Thaker A & Barton A (2012). Multicultural Handbook of Food, Nutrition and Dietetics. Wiley-Blackwell.
- Rai B & Goff L (2016). Chapter 8.3 ‘Lifestyle Management of Diabetes in Ethnic Groups’ in Goff L & Dyson P Advanced Nutrition and Dietetics in Diabetes. Wiley-Blackwell.
- The Muslim Council for Great Britain. Ramadan and diabetes: guide for patients. Available at: http://www.mcb.org.uk/wp-content/uploads/2014/06/Ramadan-and-diabetes-A-guide-for-patients-2013.pdf

9 Nutritional management of diabetes complications

9.1 Short-term complications

9.1.1 Hypoglycaemia

RECOMMENDATIONS

- An individualised approach to hypoglycaemia management with appropriate monitoring is recommended. One example of a strategy commonly recommended is:
  - Take 15–20g glucose
  - Repeat treatment if blood glucose level has not risen above 4mmol/l after 15 minutes
  - Depending on individual needs and treatment, a follow-up snack providing 15–20g carbohydrate may be necessary

Hypoglycaemia is a common acute complication affecting people with Type 1 diabetes, and people with Type 2 diabetes treated with insulin or insulin secretagogues. The prevalence of hypoglycaemia differs among different populations and evidence suggests it could be about 83% and 45% among people with Type 1 diabetes and Type 2 diabetes respectively [359, 360]. Changes in food intake, physical activity and/or medication can contribute to the development of hypoglycaemia [361]. The goal of treatment is to immediately relieve hypoglycaemic symptoms and limit the risk of injury, while avoiding over-treatment.

Glucose is the preferred treatment for hypoglycaemia, as it results in greater and more rapid resolution of hypoglycaemia [362] with a 10g and 20g dose of oral glucose, increasing blood glucose levels by approximately 2mmol/l and 5mmol/l respectively [363]. While 15–20g of glucose is the standard treatment for a hypoglycaemia, an RCT has suggested that a weight-based treatment approach may be more effective in people with Type 1 diabetes [364]. However, questions remain on practical application of such an approach.

Sucrose, in the form of sweets, sugar lumps or dissolved in water, is also effective and may be more palatable compared with glucose [362, 365-67]. Studies comparing the effectiveness of orange juice to oral glucose in resolving hypoglycaemia in adults have indicated orange juice to be less effective [366, 367]. However, the glycaemic response of a food used to treat hypoglycaemia is directly related to its glucose content, and as fruit juice and sucrose only contain half the amount of carbohydrate as glucose, a larger portion would be needed to produce the same effect [368].

Glucose levels often begin to fall approximately 60 minutes after glucose ingestion [361] leading to the practice of introducing a follow-on carbohydrate snack, despite the lack of robust supporting evidence. One small study reported that a follow-on snack providing a more sustained glucose release did not affect the likelihood of repeat

hypoglycaemia [369]. Treatment regimens and individual circumstances vary, and although glucose is recommended as a first-line treatment for any hypoglycaemic episode, taking extra starchy carbohydrate may be necessary for prolonged hypoglycaemia. It is recommended that hypoglycaemia treatment strategies are tailored to individual needs.
The prevention of hypoglycaemia is preferable to its treatment and pragmatic measures, including attending structured education programmes, have been recommended to prevent hypoglycaemia [370, 371]. The use of a bedtime snack in reducing the risk of nocturnal hypoglycaemia is not routinely recommended, but may be considered on individual basis [371, 372]. People who are at high risk of nocturnal hypoglycaemia include those with long standing diabetes, hypoglycaemia unawareness, prior physical activity, alcohol consumption or those presenting with night time blood glucose levels close to the hypoglycaemia threshold. Where lifestyle factors, such as physical activity or alcohol consumption, may contribute to hypoglycaemia, proactive steps can often be taken to minimise any risks. During prolonged physical activity, additional carbohydrate intake and/or reduction in insulin may be required to prevent hypoglycaemia and specific recommendations to meet individual needs have been provided [124, 210].

Signpost:

- https://www.diabetes.org.uk/hypo
- See section 5.1, 'Glycaemic control and Type 1 diabetes'
- Sports advice for people with Type 1 diabetes – https://www.runsweet.com

9.1.2 Diabetic ketoacidosis

Currently, there are no RCTs investigating the role of nutrition in treating diabetic ketoacidosis. National guidelines focus on the safe replacement of fluids and electrolytes, alongside weight-based fixed rate intravenous insulin infusion (FRIII).

Signpost:

- Joint British Diabetes Societies Inpatient Care Group (2013) - The Management of Diabetic Ketoacidosis in Adults https://www.diabetes.org.uk/professionals/position-statements-reports/specialist-care-for-children-and-adults-and-complications/the-management-of-diabetic-ketoacidosis-in-adults

9.2 Long-term complications

9.2.1 Macrovascular complications

9.2.1.1 Cardiovascular disease

Signposts:

- See section on cardiovascular diseases – blood lipids and blood pressure
- NICE CG181 (2016). Cardiovascular disease: risk assessment and reduction, including lipid modification. London
- NICE CG172 (2013). Myocardial infarction: cardiac rehabilitation and prevention of further cardiovascular disease. London

9.2.2 Microvascular complications

9.2.2.1 Diabetic nephropathy

RECOMMENDATIONS

- Offer individualised approach to minimise risk of malnutrition
  - Provide advice on potassium, phosphate, salt and energy intake as clinically required
  - Do not routinely restrict protein intake.

National and International guidelines [373, 374] recommend that appropriate dietary advice tailored to the stage of kidney disease should be given in relation to potassium, phosphate, salt and energy intake, ensuring malnutrition is prevented.

9.2.2.1.1 Protein intake

A recent meta-analysis of RCTs concluded that a low protein diet offers a protective effect on the progression of diabetic nephropathy by significantly improving the estimated glomerular filtration rate (eGFR) [375]. It is important to note that renal function only improved when adherence to a low protein diet was maintained.
A further meta-analysis of RCTs has reported that protein restriction is beneficial for chronic kidney disease (CKD) patients with Type 1 diabetes, but not in those with Type 2 diabetes [376]. Additional sub analysis showed that protein restricted diets are beneficial if GFR is <60ml/min/1.73m^2 and in a younger age group. These studies add to a systematic review [377], which reported that some individuals may respond to protein restriction and recommended that a six month trial may be initiated, and continued in those that respond.
The NICE CKD guideline CG 182 [373], does not recommend that patients be offered a low protein diet (dietary protein intake less than 0.6–0.8g/kg/day) due to the risk of protein malnutrition. KDIGO (Kidney Disease International Global Outcomes) [374] recommend lowering protein intake to 0.8g/kg/day in patients with GFR <30ml/min/1.73m^2 and avoiding high protein intake (>1.3g/kg/day) in adults at risk of CKD progression. On balance, it is recommended that restricted protein diets should be considered on an individual basis.

Adherence to restricted protein diets may be an issue and this has an impact on the efficacy of the diet in improving outcomes [375, 376], and one study has indicated that a specifically designed nutrition education program can improve adherence to dietary restriction in CKD [378]. The NICE guidelines [373] also highlight that dietary intervention should be part of a package of education and detailed dietary assessment.

9.2.2.2 Lower limb ulcers and amputations

RECOMMENDATIONS

- Assess nutritional status and offer an individualised approach to minimise malnutrition, and optimise glycaemic control.

Optimal glycaemic control is important for preventing and slowing the rate of progression of all diabetes-related complications and may specifically reduce the risk of amputation in people with diabetic foot ulcers [379].
Nutritional assessment is important in people with diabetic foot ulcers. Observational studies have reported that poor nutritional status can interfere with wound healing in people with diabetic foot ulcers [380] and was associated with an increased likelihood of a lower limb amputation [381]. Nutritional status also deteriorated with increasing severity of diabetic foot ulcers [382] and lower limb amputations [381], and severity of malnutrition was a predictor of poor prognosis in people with diabetic foot ulcers [380].
There may be a role for specific nutrient supplementation in people with diabetic foot ulcers and infections. Observational studies have reported that vitamin D deficiency is more prevalent and severe in people with diabetic foot infections and people who have vitamin D deficiency are more susceptible to infection, suggesting there may be a role for vitamin D supplementation [382, 383]. However there have been no studies that have shown vitamin D supplementation plays a direct role in wound healing, although it may affect healing indirectly through improved glycaemic control [384]. Other studies have suggested a role for zinc [385] and the amino acids, arginine, glutamine, and beta-hydroxy-beta-methylbutyrate, [386]. Further larger scale studies are needed to determine the role of nutrition in the management of diabetic foot ulcers.
The NICE guidelines on prevention and management of diabetic foot problems support nutritional interventions in people with diabetic foot problems and recommend access to nutritional services (see signpost).
If an individual needs an amputation, their nutritional status should be assessed and reviewed appropriately, and as with all surgical procedures, nutritional support should be offered to those in a poor nutritional state.

Signpost

- See: Nutrition support
- National Institute for Health and Care Excellence (2015). Diabetic foot problems: prevention and management [NG19]. London, NICE.

9.2.2.3 Diabetic gastroparesis

RECOMMENDATIONS

- Offer individualised care to meet nutritional requirements, manage symptoms and optimise glycaemic control.

Gastroparesis, or chronic delayed gastric emptying without mechanical obstruction, is associated with poor glycaemic control, increased risk of bezoars [387] and reduced quality of life [388] in people with diabetes. Gastroparesis should be considered when blood glucose control becomes erratic and unpredictable or if hypoglycaemia becomes unusually problematic or of increased frequency [387, 388]. It usually causes vomiting and weight loss with poor oral intake, an energy-deficient diet, and deficiencies in vitamins and minerals [389, 390].
There are no evidence-based guidelines relating to the nutritional management and current dietary recommendations are based on consensus recommendations [3891, 392]. They state that the management of diabetic gastroparesis should include:

- assessment and correction of nutritional status
- relief of symptoms
- improvement of gastric emptying
- optimisation of glycaemic control.

The choice of nutritional support depends on the severity of disease. In mild diabetic gastroparesis, maintaining oral nutrition is the goal of therapy and dietary recommendations rely on measures that optimize gastric emptying, including:

- low-fat, low-fibre meals [391]
- small, frequent meals [391]
- complex carbohydrates [392]
- energy dense liquids in small volumes e.g. pureed foods and liquids [391].

Increasing the liquid nutrient component of a meal should be advocated, as gastric emptying of liquids is often normal in people with delayed emptying of solids. High energy liquid supplements may be required to fulfil daily energy requirements and many people are not adversely affected by dietary fat if it is present in liquid form [392].
NICE guidance recommends a small-particle-size diet for symptomatic relief for adults with Type 1 and Type 2 diabetes who have vomiting caused by gastroparesis (see signpost). In some people, carbonated beverages can aggravate gastric distension; their intake should be minimized. Alcohol and tobacco smoking should be avoided because both can modify gastric emptying [391].
For people with severe gastroparesis who are unable to maintain nutrition with oral intake, a feeding jejunostomy tube, which bypasses the affected stomach, can improve symptoms and reduce hospitalizations [393].
In people who are unable to maintain adequate nutrition through oral intake, enteral or, in extreme cases, parenteral nutrition may be required [392].
As hyperglycaemia and ketoacidosis can promote gastroparesis, optimisation of glycaemic control is recommended [391, 392]. Since acute hyperglycaemia inhibits

gastric emptying, it is assumed improved glycaemic control may improve gastric emptying and reduce symptoms. However the efficacy of long term improvement in glycaemic control on normalisation of gastric emptying and relief of symptoms in people with diabetes is controversial [391], and the impact of improved glycaemic control on gastric emptying and vice versa in diabetes is unknown [394]. Nevertheless, short and long-term glycaemic control is indicated for improved long-term outcome of diabetes and current guidance on the management of gastroparesis advocates optimisation of glycaemic control [391, 392].

Signposts:

- National Institute for Health and Care Excellence (2015). Type 1 diabetes in adults: diagnosis and management [NG 17]. London, NICE
- National Institute for Health and Care Excellence (2015). Type 2 diabetes in adults: management [NG 28]. London, NICE

9.2.2.4 Retinopathy

There are no RCTs specifically investigating the role of diet in the management of diabetic eye disease. Although the risk of developing diabetic retinopathy is influenced by glycaemic control, and systemic factors such as blood pressure and cholesterol [395, 396], there is lack of evidence to support the specific role of blood pressure control in slowing the progression of diabetic retinopathy [397, 398]. However, it is recommended that medical management of diabetic retinopathy should target the control of glycaemia, blood pressure and lipids [399-401] so dietary advice should be appropriately offered as part of the package of care.

10 Other special considerations

10.1 Nutrition support

RECOMMENDATIONS

- Aim to meet nutritional requirements and adequacy
  - Adjust diabetes treatment to optimise glycaemic control
  - Deliver support from a multi-disciplinary team.
- General enhanced recovery after surgery protocols can be recommended, depending on individual clinical situation.
- Diabetes specific formulae enteral feeds can be recommended, but are not routinely used in the UK.

Upwards of 25% of hospital inpatients may have diabetes [402] and many will require nutrition support [403]. Much of the evidence for nutrition support relates to the use of Diabetes Specific Formulae (DSF) as both sip feeds and as enteral feeds. Nutritional support and management benefits from a multidisciplinary team approach to optimise glycaemic control [404].

Hyperglycaemia is common in hospitalised patients and an important marker of poor clinical outcome and mortality in patients [405, 406]. Optimising glucose control is paramount and is associated with better outcomes in conditions including accidental injury, stroke and critical illness, where hyperglycaemia predicts worse outcomes [406]. Enteral feeding is recommended where possible for all patients in order to take advantage of the incretin response [406]. Patients requiring parenteral nutrition should be treated with standard protocols and treated with adequate insulin to maintain normoglycaemia. If parenteral nutrition is used, no more than 2g glucose per kg bodyweight per day should be given until glycaemic control is achieved [406]. Generally, Enhanced Recovery After Surgery (ERAS) protocols can be applied to people with diabetes [406].

The risk of frailty and sarcopenia is higher in people with diabetes [407] and therefore dietary restrictions need to be considered carefully to ensure that nutritional adequacy is achieved [408]. There is some evidence to suggest that modified insulin regimens may minimise excursions in glycaemia [409, 410]

10.1.1 Diabetes Specific Formula (DSF)

A systematic review of RCTs found DSF reduce postprandial glucose concentrations, HbA1c and insulinaemic responses [411]. A retrospective analysis also suggested that DSF are associated with shorter lengths of hospital stay and reduced costs for both orally and enterally fed individual [412]. However, DSF are not routinely used in the UK.

10.2 Older people with diabetes

RECOMMENDATIONS

- Offer education, including dietary intervention, to older people with diabetes. Age should not restrict access to education.
- Assess nutritional status and care plans under the supervision of a dietitian.
- Adapt general guidelines for people with diabetes for those with dementia.

Nutrition may be compromised as people age, with physical, social and psychological factors all playing a part. There is some evidence that the older person with diabetes may have poorer nutritional status than those without diabetes, both in the community [413] and in hospital [414]. However, age should not restrict access to structured education and self-management, as education has been shown to be effective in older adults [415, 416].

Loss of lean tissue can be more rapid in older people living with diabetes when compared with those without diabetes [417]. This results in challenges meeting dietary requirements, as nutrient requirements, especially protein and some vitamins and minerals increase, although energy requirements fall [418].

Assessment of nutritional status and support for those who may be malnourished should be available to all elderly people with diabetes, with nutritional care plans being individualised and overseen by a dietitian [419, 420].

There is little evidence regarding the nutritional management of people living with both dementia and diabetes. Research is ongoing to develop pragmatic strategies to support this group [421]. Recommendations for people without diabetes who have dementia should be adapted with a focus on maintaining nutritional adequacy and preventing malnutrition [422].

10.3 Diabetes care in institutions

RECOMMENDATIONS

- Offer access to education, including dietary intervention, to people in institutions.
- Provide menus with nutritional information, including carbohydrate content.

Some people with diabetes are not in charge of their own nutrition and have their food provided to them with varying degrees of choice. Menus in all institutions should be designed to include healthy choices for people with diabetes and facilitate self-management. This should include consistency of serving sizes and information about carbohydrate content. As well as nutritional management to support optimal diabetes control, other nutritional issues should be considered, including the risk of malnutrition. The ageing population has resulted in larger numbers of older people with diabetes living in residential care homes. A large proportion of hospital inpatients also have diabetes (see section on nutrition support).

In residential care homes, traditional restrictive diabetes diets may result in undernutrition and unintentional weight loss and there is some evidence that a more liberal diet, with a consistent amount of carbohydrate at each meal or snack improves outcomes [423, 424].
Recommendations for people with diabetes in prison or correctional institutions include a combination of education, interdisciplinary communication and individualised dietary advice [425, 426].
People with diabetes should have a review of their diabetes as soon as possible after moving to a new institution of any type. This should include an individualised review of nutritional management [425] and consideration should be made for including a dietitian in this process [427].

10.4 Pregnancy

RECOMMENDATIONS

Women living with diabetes (both Type 1 and Type 2 diabetes) prior to conception should:

- receive support from a multidisciplinary team, including referral to a dietitian
- aim to achieve and maintain optimal glycaemic control before and during pregnancy
- aim to lose weight before pregnancy if overweight or obese and maintain appropriate weight gain during pregnancy
- take 5mg folic acid/day before pregnancy until the end of the 12th week of pregnancy.

Women diagnosed with gestational diabetes should:

- be referred to a dietitian for dietary advice
- aim to achieve appropriate weight gain
- take regular physical activity, including walking for 30 minutes after a meal to lower postprandial glucose concentrations.

10.4.1 Women with Type 1 and Type 2 diabetes

10.4.1.1 Preconception

Preconception care for women with Type 1 and Type 2 diabetes is associated with improved outcomes [428], and all women with established diabetes should receive preconception care to optimise glycaemic control, assess risk of complications and review medications [429]. Dietary advice by a dietitian is recommended to optimise glycaemic control, and to promote adequate nutritional intake and appropriate weight gain [430]. Recommendations include:

- optimising glycaemic control, including referral to a dietitian for individualised dietary advice
- taking 5mg folic acid/day and continuing until the end of the twelfth week of pregnancy

- weight loss for women who have a BMI above 27 kg/m² to achieve an appropriate weight.

10.4.1.2 During pregnancy

Hyperglycaemia during pregnancy is associated with adverse outcomes [431] and women with diabetes require multidisciplinary team expertise to optimise glycaemic control [429]. Recommendations include:

- individualised dietary advice to promote adequate nutritional intake and achieve optimal glycaemia appropriate for gestational age [429]
- monitoring weight to ensure appropriate weight gain during pregnancy, based on prepregnancy BMI [432]. NICE does not recommend routine monitoring of weight during pregnancy, although there is growing evidence of the risks associated with obesity in pregnancy [433]
- moderate physical activity of 30 minutes/day in uncomplicated pregnancies [434]
- taking a vitamin D supplement (10µg/day; equivalent to 400IU/day), as recommended for all pregnant women [434, 435].

10.4.1.3 Breastfeeding

Breastfeeding is recommended for all women both for its protective effects on the infant and mother postpartum and for the long-term effects on reducing the risk of chronic disease, including Type 2 diabetes [436-439]. All women are encouraged to breastfeed exclusively for six months [439]. For women with Type 1 diabetes, breastfeeding is recommended immediately after delivery to reduce neonatal hypoglycaemia [429] and to increase insulin sensitivity longer term [440]. Breastfeeding may cause hypoglycaemia [441] and requires increased frequency of glucose testing, reductions in insulin and an increased carbohydrate intake.

10.4.2 Gestational diabetes (GDM)

10.4.2.1 Prevention of GDM

There is strong evidence that lifestyle modifications reduce the incidence of GDM in women at high risk [442-445]. The risk of GDM can be reduced by 39% after implementation of individualised lifestyle interventions, including increased physical activity and improved diet quality [438]. Evidence also supports avoiding excessive gestational weight gain [446].

Evidence from groups of women at moderate risk reports inconsistent results [447], including interventions based solely on dietary change [448-451] and those with increased physical activity [445, 452]. Robust evidence for the role of nutritional supplements such as probiotics and myo-inositol [449, 453] and vitamin D [454] in the prevention of GDM is lacking.

10.4.2.2 Management of GDM

In the UK, approximately 16% of pregnant women are diagnosed with GDM, although prevalence rates vary widely depending on the diagnostic criteria used [455]. Untreated GDM increases risk of maternal and perinatal morbidity and mortality and the recommended first-line treatment is dietary modification and increased physical activity [429]. Dietary advice from a dietitian is recommended to optimise glycaemic control

and to promote adequate nutritional intake and appropriate weight gain, but there is no conclusive evidence for the most effective diet for improving health outcomes [456]. Nutritional management of GDM has historically focused on carbohydrate restriction and low GI diets, but there is little evidence to support these approaches [456, 457]. Women with GDM are advised to maintain levels of physical activity in line with general guidelines for adults (150 minutes of moderate activity per week) as this improves glycaemic control [458], and there is some evidence that walking for 30 minutes after a meal reduces blood glucose concentrations [429].
Weight management for women with GDM is controversial. NICE recommends that weight should be monitored and that weight loss should be avoided [429], but evidence of adverse outcomes associated with excessive gestational weight gain [459] implies that active weight management may be required. The balance of evidence suggests that monitoring of weight is justified, and weight gain close to suggested levels from the Institute of Medicine (IOM), based on pre-pregnancy BMI, should be encouraged [432].
Breastfeeding is recommended for women with GDM to reduce neonatal hypoglycaemia, improve insulin sensitivity and it may also reduce maternal risk of developing Type 2 diabetes in the future [436, 460-63).
Women with previous GDM have an increased lifetime risk of developing Type 2 diabetes [464] and their offspring are at higher risk of developing childhood obesity [465]. Postpartum advice on lifestyle modification is recommended.

Signposts:

- National Institute for Health and Care Excellence (2015). Diabetes in pregnancy: management from preconception to the postnatal period [NG3]. London, NICE https://www.nice.org.uk/guidance/ng3
- National Institute for Health and Care Excellence. Diabetes in pregnancy (2016). [QS109]. London, NICE. https://www.nice.org.uk/guidance/qs109
- National Institute for Health and Care Excellence (2017). Antenatal care for uncomplicated pregnancies [CG62]. London, NICE. https://www.nice.org.uk/guidance/cg62
- National Institute for Health and Care Excellence. Maternal and child nutrition [PH11]. London, NICE; 2008. https://www.nice.org.uk/guidance/ph11

10.5 Coeliac disease

RECOMMENDATIONS

- Offer individualised advice by a specialist dietitian to all people with coeliac disease and diabetes.
- Recommend adherence to a gluten-free diet.

Individuals with Type 1 diabetes are at increased risk of coeliac disease, with more than one in 20 people with Type 1 diabetes having the condition [466]. There is no evidence to suggest an increased risk of coeliac disease in people with Type 2 diabetes. It is recommended by NICE that people with Type 1 diabetes be offered a serological test for coeliac disease due to this increased risk [467].

Evidence is inconclusive as to the effect of coeliac disease on glycaemic control, however epidemiological studies indicate increased mortality, higher microvascular complications (nephropathy and retinopathy) and impaired bone health in adults with both coeliac disease and Type 1 diabetes [468, 469]. Results of the ongoing CD-DIET multicentre RCT will inform on the benefits of adopting a gluten-free diet on glycaemic control and complications in asymptomatic children and adults with coeliac disease and Type 1 diabetes [470].
Patients with coeliac disease should adhere to a gluten-free diet and have an intake of less than 10mg gluten per day [471]. As a gluten-free diet is the primary treatment option, a specialist dietitian should be accessible to provide advice.

Signposts:

- NICE (2015) ng20 Coeliac disease: recognition, assessment and management
- NICE (2015) ng17 Type 1 diabetes in adults: diagnosis and management
- Coeliac UK https://www.coeliac.org.uk
- Diagnosis and management of adult coeliac disease: guidelines from the British Society of Gastroenterology (2014)

10.6 Cystic fibrosis-related diabetes (CFRD)

RECOMMENDATIONS

- Provide individualised dietary and insulin education and advice to optimise nutritional status, weight and glycaemic control.
- Avoid unnecessary dietary energy restrictions.
- Provide education to support people to identify and quantify carbohydrates to manage glycaemic control, including during supplementary feeding.

Cystic fibrosis (CF) is the most common autosomal recessively inherited genetic condition in those of northern European descent, affecting 1 in 2500 births. Lower birth prevalences are reported in other ethnic groups including white Americans (1 in 3000), Latin Americans (1 in 4,000 – 10,000) and African Americans (I in 15,000 – 20,000). CF is uncommon in Africa, Asia and Japan [472].The advancement of medical therapies in CF has dramatically improved survival in CF patients and median age of survival is 41.4 years [473-477].
Cystic fibrosis-related diabetes (CFRD) is the most common co-morbidity associated with CF. Studies indicate CFRD affects 26% of adolescents with CF and between 40 and 50% adults over the age of 30 years (476, 478, 479) with CF. It has been estimated that between 70 and 90% of all adults with CF will have some degree of glucose intolerance by 40 years of age [480, 481].
Cystic fibrosis-related diabetes is a distinct entity which shares features of Type 1 and Type 2 diabetes. The onset is insidious and glycaemic status varies according to the patient's genetics and clinical status. CFRD is associated with weight loss, protein catabolism, decline in lung function and increased mortality 2-4 years prior to diagnosis. This is associated with the loss of anabolic effects of insulin and poor glycaemic control [475, 478, 479, 482, 483]. The aetiology of CFRD is complex and not completely understood; it is likely a combination of insulin deficiency and insulin resistance due to inflammation, glucocorticoids and genetics.

Screening and treatment of this disorder is essential in those with CF and insulin is considered the optimal treatment. Nutrition therapy is essential although dietary management of CFRD is very different to Type 1 and Type 2 diabetes. Education for CFRD must be tailored to the specific needs of the patient with CF and diabetes. [478, 477, 484]
There are currently no RCTs investigating dietary intervention in the management of CFRD. Recommendations are based on cohort studies and current clinical consensus guidelines [478, 484, 485]. The main treatment goal for CFRD patients is optimising nutritional status to improve longevity [486, 487]. Nutritional requirements in CF are well established but malnutrition is common, due to maldigestion/malabsorption, declining lung function, increased resting metabolic rate, anorexia and gastro oesophageal reflux which leads to vomiting.

10.6.1 Energy intake

Adequate energy intake is required to achieve and maintain an optimal BMI, which is critical to health and survival; therefore no dietary restrictions are recommended [473, 478, 479]. A high-fat, high-energy, high salt diet is advised, in view of increased requirements and the low risk of CVD. A recent study reported that 12.1% of CF patients are overweight or obese [488] and revision of current recommendations may be required in the future.

10.6.2 Carbohydrate

No restrictions are placed on total carbohydrate intake and insulin doses should be adjusted to intake. In general, free sugars should be avoided and replaced by unrefined carbohydrate or low GI foods together with protein and fat, reducing glucose excursions [484, 489, 490].
Supplemental feeding is often required and frequent monitoring of blood glucose levels is advised. Appropriate education programmes designed to optimise glycaemic control are recommended to reduce the risk of long term complications and optimise nutritional status. [479, 486]

10.6.3 How nutrition management of CFRD differs from Type 1 and Type 2 diabetes.

Energy: In general, people with CFRD are recommended to have 120–50% of the required energy [473, 479] compared with people with Type 1 and Type 2 diabetes, who usually aim for less than the required energy for their age.
Carbohydrates: People with CFRD are recommended to have about 45–65% of their total energy from carbohydrates [473, 479], unlike people with Type 1 and Type 2 diabetes who do not have a specific recommendation for the amount of energy to be derived from carbohydrates.
Fat: People with CFRD are recommended to have up to 40% of their total energy from fat [473, 479] unlike people with Type 1 and Type 2 diabetes who do not have a specific recommendation for the amount of energy to be derived from fat.
Protein: People with CFRD are recommended to have 200% of their reference nutrient intake for protein [473, 479] compared to people with Type 1 and Type 2 diabetes who do not have a specific recommendation for protein intake.
Salt: People with CFRD do not have any salt restriction [473, 479] due to their low CVD risk, compared to the 6g/day restriction for people with Type 1 and Type 2 diabetes.

Fibre: For people with CFRD, fibre intake should not be prioritised over high energy intake. Fibre could be encouraged so long as it does not compromise high energy intake [473, 479]. People with Type 1 and Type 2 diabetes are recommended to have 30g fibre a day.

Signposts:

- https://www.cysticfibrosis.org.uk/~/media/documents/the-work-we-do/care/consensus-documents-with-old-address/nutritional-management-of-cystic-fibrosis-sep-16.ashx?la=en
- http://www.espen.org/files/ESPEN-Guidelines/2__ESPEN-ESPGHAN-ECFS_guidelines_on_nutrition_care_for_infants_children_and_adults_with_cystic_fibrosis.pdf
- https://www.cff.org/Care/Clinical-Care-Guidelines/

10.7 Diabetes in HIV

RECOMMENDATIONS

- Offer individualised multi-component interventions to treat antiretroviral-associated weight gain to reduce risk of Type 2 diabetes.
- Follow diet and physical activity recommendations for the general diabetes population to manage diabetes in people with HIV.

10.7.1 Background

Malnutrition associated with HIV infection, once highly prevalent, is now rare in those treated with antiretroviral medicines. However, overweight and obesity are now highly prevalent, and are present in up to two-thirds of those living with HIV [491]. In the developed world, metabolic abnormalities such as coronary heart disease and diabetes are now the main cause of morbidity and mortality in HIV [492]. Taken as a whole, the HIV cohort is ageing [493] and as the risk of developing Type 2 diabetes is up to four times higher than the HIV negative population, new HIV-associated diabetes diagnoses will continue to present, unless prevention is prioritised [494, 495].

10.7.1 Clinical challenges

The screening and management of prediabetes and Type 2 diabetes in HIV present distinct challenges. Specific antiretrovirals have a variable influence on the relationship between HbA1c and fasting glucose, and can result in underestimation of HbA1c by up to 6mmol/mol (0.5%), potentially leading to under-treatment of established diabetes [496, 497]. People living with HIV and Type 2 diabetes may have a poorer response to diabetes treatments compared with HIV negative individuals [498]. A meta-analysis of RCTs indicated that pharmaceutical interventions for diabetes may be limited in HIV, due to interactions with antiretrovirals [495]. For example, the commonly-used antiretroviral dolutegravir interacts with metformin, requiring frequent dose adjustment [500], and the use of metformin in patients with lipoatrophy can lead to worsening of facial wasting [501].

10.7.2 Identifying insulin resistance and diabetes risk in HIV

The use of HbA1c in conjunction with a fasting glucose measurement or preferably an oral glucose tolerance test has been proposed to be the most reliable method for diabetes screening in HIV [502]. Additionally, HOMA-IR (homoeostasis model for assessment of insulin resistance) accurately predicts insulin resistance in HIV [503].

10.7.3 Treatment and prevention of insulin resistance and diabetes in HIV

Expert opinion suggests lifestyle intervention as advised for the general diabetes population should be a primary treatment in HIV care [504]. Weight gain following initiation of antiretrovirals is associated with increased risk of later development of Type 2 diabetes [501, 505] and can be mitigated by individualised diet and physical activity interventions [506]. However, there is limited data regarding the role of diet and physical activity interventions for managing insulin resistance and diabetes in HIV. Both strength and endurance exercise may improve insulin sensitivity in HIV lipodystrophy [507]. There is also some evidence that an intensive diet and exercise intervention resulted in very modest reductions in HOMA-IR but not HbA1C [508]. Further study is needed to strengthen the evidence base for the efficacy of practical lifestyle interventions in HIV positive people with insulin resistance and diabetes.

10.8 Eating disorders

RECOMMENDATIONS

- Consider the possibility of disordered eating or other control behaviours relating to food in adults with diabetes.
- Use suitable screening tools to identify possible eating disorders at the earliest opportunity.
- Consider an early referral to local eating disorder services.

Eating disorders such as anorexia, bulimia and binge eating disorder are up to 10 times more likely in people with Type 1 and Type 2 diabetes [509-513]. Adolescents and young women are at greatest risk of eating disorders, with prevalence rates estimated at 10–40% [509]. There is an observed association between eating disorders and poorer glycaemic control in both Type 1 and Type 2 diabetes, especially among adolescents with Type 1 diabetes [510, 512].

In Type 1 diabetes, reduced insulin dose or insulin omission is used as an aid to weight loss and is common amongst adolescent girls and young women and has been termed ‘diabulimia’ [514, 515]. Studies suggest that between 10–42% of young women omit insulin [510]. Deliberate omission of insulin can be due to a number of reasons but may be related to issues of disordered eating and has serious consequences, including increased risk of DKA and diabetes complications [516].

Screening tools and treatment guidelines for eating disorders exist (see signposts) and are probably applicable to people with diabetes. However screening tools specific to diabetes have recently been developed. In Type 1 diabetes the Screen for Early Eating Disorders Signs (SEEDS) is a brief 20-item tool that can help identify people who may need early referral to eating disorder specialist services [517]. The modified version of

the short SCOFF eating disorders screening tool for diabetes, the mSCOFF, shows good agreement with a much longer mEDI tool for screening for eating disorders in adolescent females with Type 1 diabetes [518]. In the absence of a suitable screening tool, the following signs should prompt further assessment in young people with Type 1 diabetes:

- poor treatment adherence
- low BMI
- over-concern with body shape and weight
- sub-optimal blood glucose control.

Most eating disorder guidelines support a multidisciplinary approach and if healthcare professionals involved with diabetes care feel ill-equipped to deal with patients who have eating disorders [519] they should refer the patient to eating disorder units (see signpost).

Signposts:

- NICE (2004) – Eating disorders in over 8s: management. CG9. National Institute for Health and Care Excellence.
- NICE (2017) Eating disorders: recognition & treatment. National Institute for Health and Care Excellence.
- NICE (2015) – Type 1 diabetes in adults: diagnosis and management. NG17. National Institute for Health and Care Excellence, London.
- National Centre for Eating Disorders – https://www.eating-disorders.org.uk
- National Charity for People with Eating Disorders and their Families: B-EAT – https://www.b-eat.co.uk

11 Micronutrients, food supplements and functional foods

RECOMMENDATIONS

- Do not recommend micronutrient supplementation to manage or prevent diabetes.
- Encourage individuals choosing to use supplements to discuss their individual needs with a registered dietitian.

11.1 Micronutrients

There is considerable evidence from observational studies demonstrating alterations in micronutrient status (vitamins, minerals and trace elements) in people with Type 1 [520, 521] and Type 2 diabetes [522], but the clinical implications remain unclear. The association seen in these observational studies between micronutrient levels and diabetes does not demonstrate causation, and there is little evidence to elucidate the role of dietary deficiencies. Data from RCTs investigating the effects of supplementation are limited, and all trials use supplements rather than food.

11.1.1 Vitamins

Lower concentrations of thiamine, niacin, pyridoxine, folic acid and vitamins C, D and E have been described in people with Type 2 diabetes [523], and although less is known about people with Type 1 diabetes, low concentrations of vitamin D have been reported [524]. Prospective cohort studies indicate that higher intakes of vitamin D are associated with a lower incidence of Type 2 diabetes [525]. Although epidemiological studies have indicated an association between low concentrations of serum 25-hydroxyvitamin D3 and increased risk of diabetes, meta-analyses of RCTs to date have failed to show a significant effect of vitamin D supplementation on insulin resistance and glycaemic control in people at high risk of Type 2 diabetes or diabetes incidence in general [526, 527]. There is little evidence of the effect of supplementation of vitamins other than vitamin D [528] and folic acid in pregnancy (see section 10.4).

11.1.2 Minerals

Observational studies report that ferritin is strongly associated with an increased risk of Type 2 diabetes [529] and that higher intakes of calcium are associated with a lower risk of Type 2 diabetes [530]. There is little evidence from intervention studies, and further research is needed before formulating specific recommendations.

11.1.3 Trace elements

Studies have investigated the association between concentrations of zinc, magnesium, chromium, copper, manganese and selenium and diabetes, but results are equivocal. Individuals with Type 2 diabetes have been reported to have lower zinc levels, and a few studies have demonstrated benefit from zinc supplementation [531]. Higher intakes of dietary magnesium have been associated with a lower incidence of Type 2 diabetes, and magnesium supplementation improves glycaemic control and reduces cardiovascular risk in those with diagnosed diabetes [532], and improves insulin sensitivity in those at risk of diabetes [533]. Recent studies suggest a positive effect of

chromium picolinate supplementation on glycaemic control, although the long-term effects are unknown [534].

11.2 Food supplements

Traditional medicine often includes complementary therapies of plant origin that are taken as supplements and the most commonly used include bitter melon (kerela), cinnamon and fenugreek, although there are others, including aloe, garlic and gymnema [535].

Bitter melon is a vegetable with purported hypoglycaemic properties, although this has been largely disproven by a meta-analysis of RCTs that reported no significant improvement in glycaemia [536]. Cinnamon contains hyroxychalcone, which is thought to enhance insulin action, but there is insufficient evidence to support its use as an effective therapy for diabetes [537]. Fenugreek is a popular remedy for Type 2 diabetes, and although a recent meta-analysis reported hypoglycaemic effects, conclusions were limited by low quality studies [538]. Turmeric, due to it the curcumin content, has been shown to have hypoglycaemic properties in animal studies, but few clinical trials have been conducted [539].

11.3 Functional foods

There are few clinical studies investigating the effects of functional foods in people with diabetes apart from plant sterols and stanols (see signpost).

Signpost:

- The use of n-3 supplements and plant stanols/sterols is discussed in section 7.8

12 Commercial diabetic foods, sugars and other sweeteners

RECOMMENDATIONS

- Avoid food labelled ‘diabetic’ or ‘suitable for diabetics’.
- Reduce intake of free sugars, sugar-sweetened beverages, added fructose and polyols.
- Non-nutritive (artificial) sweeteners are safe and may be recommended.

12.1 Commercial diabetic foods

Specially formulated foods labelled as ‘diabetic’ or ‘suitable for diabetics’ have not been recommended in the UK for over 30 years [1-4]. None have any evidence for benefit. Labelling a food as ‘diabetic’ misleads the consumer as it implies a health benefit. So-called diabetic foods are often energy dense and contain similar amounts of energy and saturated fat as standard products, and they have a laxative effect when consumed in large amounts.

A report from the European Commission (EC) in 2008 stated that [540]:

- There are no grounds for developing specific compositional requirements for foods intended for people with diabetes.
- People with diabetes should be able to meet their dietary needs by appropriate selection from everyday foods.

As a result, the EC reviewed legislation for foods for particular nutritional uses (PARNUTS) and purposefully omitted diabetic foods, ruling that special foods are not needed for people with diabetes [541]. Since revocation of the old PARNUTS directive, the assertion ‘suitable for diabetics’ is now classified as a health claim and is not authorised for use in the UK and the rest of the European Union (EU).

12.2 Sugars

Sugars, also known as nutritive sweeteners, provide energy in the form of carbohydrate. In 2015, the term ‘free sugars’ was adopted to include monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates [7, 542]. In the UK, it is recommended that the average population intake of free sugars should not exceed 5% of total dietary energy for age groups from 2 years upwards [7]. This recommendation should also apply to people with diabetes.

12.2.1 Sucrose

There is evidence that substitution of sucrose for isocaloric amounts of other carbohydrate for up to 35% of energy may not adversely affect glycaemia or lipid levels in people with diabetes [543]. However, because foods and drinks high in sucrose are generally energy dense, substitution should be made in the context of an overall healthy eating pattern [71].

Evidence from prospective cohort studies has shown that sugar-sweetened beverages are linked to weight gain and increased risk of Type 2 diabetes [7]. Guidelines for the general population recommend that the habitual consumption of sugar-sweetened beverages should be avoided or minimised to reduce the risk of weight gain and Type 2 diabetes [7]. There is also evidence of worsening of cardiometabolic risk factors with large intakes of dietary sugars [544].
There are currently no specific sugar recommendations in diabetes management. People with diabetes should be encouraged to reduce sugar intake in line with recommendations for the general population. In those who are overweight, the reduction of free sugars should be part of a strategy to decrease energy intake [7].

12.2.2 Fructose

Special concerns have been expressed about the use of fructose as a nutritive sweetener in people with diabetes [545]. However, two systematic reviews and meta-analyses of trials that were mostly RCTs conducted in people with diabetes, have reported that free fructose (naturally occurring in foods such as fruit) consumption is not more deleterious than other forms of sugar unless intake exceeds approximately 12% of total caloric intake [545, 546].
A systematic review and meta-analysis of controlled feeding trials in people with diabetes reported that isocaloric exchange of fructose for other carbohydrates reduced glycated blood proteins and did not significantly affect fasting glucose or insulin [547], although conclusions were limited by the short duration of studies.
In terms of specific adverse effects of fructose, there is evidence of elevations in serum triglycerides in general populations [548, 549]. There is some controversy, with evidence from a recent systematic review and meta-analysis of controlled feeding trials reporting that isocaloric exchange for other carbohydrates does not increase postprandial triglycerides, although a pooled analysis showed that excess energy from fructose did increase postprandial triglycerides [550].
The quality of evidence for the effects of fructose in diabetes is limited, and the recent SACN report stated that there was insufficient evidence to demonstrate that usual intakes of fructose lead to adverse health outcomes [7].

12.2.3 Polyols

Polyols (sugar alcohols) are nutritive sweeteners that include hydrogenated mono- and disaccharides and hydrogenated oligo- and polysaccharides, e.g. hydrogenated starch hydrolysate and polyglycitol. They are found naturally in some fruits and are manufactured. Commercial polyols deemed safe and permitted for use in the UK include erythritol, isomalt, lactitol, maltitol, mannitol, sorbitol, and xylitol [551]. They are used in food and drinks to replace sugars and are digested and utilised differently to sugars, providing fewer calories and having little or no effect on postprandial glycaemia [552].
There is wide variation in the absorption and colonic fermentation of different polyols, leading to variations in glycaemic effect and estimated energy values [552]. Currently there is no evidence for the effect of polyols generally in people with diabetes. A systematic review of RCTs found inconclusive evidence for the role of specific polyols in glycaemic control [553].

The laxative effect of polyols has been widely reported and current legislation requires foods containing more than 10% added polyols to bear the statement 'excessive consumption may produce laxative effects' on the label (see signpost).

12.3 Non-nutritive sweeteners

Non-nutritive sweeteners (NNS; also known as artificial sweeteners or sugar substitutes) provide little or no calories and have no effect on glycaemia [543]. There are eleven types of NNS licensed for use in the UK; examples include acesulfame potassium (acesulfame-K), aspartame, cyclamate, saccharine, stevia and sucralose. Non-nutritive sweeteners are classed as food additives, evaluated for their safety and have been deemed as safe permitted foods additives by the EU [554]. The evidence shows that NNS are considered safe to consume up to the Acceptable Daily Intake (ADI) in the general population, with the exception of foods for infants and young children. Artificial sweeteners are also safe for people with diabetes when consumed within the ADI [554] and the EFSA Panel concluded that there is sufficient scientific information to support the claims that intense sweeteners lead to lower postprandial blood glucose concentrations if consumed instead of sugars [555].

For people who are accustomed to sugar sweetened products, NNS have the potential to reduce overall energy and carbohydrate intake and may be preferred to sugar when consumed in moderation and can be a useful strategy for those individuals seeking to control their calorie intake and manage their weight [556]. A recent meta-analysis of RCTs and prospective cohort studies investigating the effects of NNS on body weight found that substituting NNS options for regular, energy-dense versions resulted in a modest weight loss [557] and a further recent systematic review and meta-analysis of observational studies, RCTs and animal studies concluded that intakes of NNS in place of sugar may be helpful in reducing energy intake and body weight in children and adults [558]. However, results were inconsistent and showed wide variation between studies.

An American Heart Association (AHA) and American Diabetes Association (ADA) scientific statement on NNS consumption concluded that there was not enough evidence to determine whether NNS use actually leads to a reduction in body weight or reduction in cardiometabolic risk factors [559]. These conclusions are consistent with a systematic review of hypocaloric sweeteners (including polyols) that found little evidence that use of NNS leads to reductions in body weight [553]. It has also been argued that NNS may paradoxically increase weight in the longer term [560]. However, evidence is inconclusive and further research is warranted.

Signpost:

- UK Food labelling: giving food information to consumers. https://www.gov.uk/guidance/food-labelling-giving-food-information-to-consumers

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Appendix A: Summary of recommendations with Evidence GRADE

Nutrition management and models of education and care delivery

RECOMMENDATIONS	Evidence GRADE
• Nutrition management is recommended as part of an integrated package of education and clinical care for all people with diabetes and those at risk of developing Type 2 diabetes	4
• Offer on-going nutritional advice guided by a registered dietitian to all people with diabetes, and those at high risk of Type 2 diabetes	3
• Offer structured diabetes education at the time of diagnosis with annual follow-up	3
• Adopt a person-centred approach and a variety of learning styles during education	NR
• Offer culturally sensitive multi-component education and interventions to people from ethnic minority groups	4

Prevention of Type 2 diabetes

RECOMMENDATIONS	Evidence GRADE
• Aim for weight loss of at least 5%, where appropriate, to reduce the risk of Type 2 diabetes in high risk groups	4
• Key recommendations for lifestyle interventions to reduce risk of Type 2 diabetes in high risk groups include:	4
▪ Restrict energy intake	
▪ Reduce total and saturated fat intake	
▪ Increase fibre intake	
▪ Increase physical activity	
• Dietary patterns associated with reduced risk in general populations include:	
▪ Mediterranean diet	4
▪ DASH diet	2
▪ Vegetarian and vegan diets	2
▪ The Nordic healthy diet	2
▪ Moderate carbohydrate restriction	
• Include more specific foods associated with reduced risk in general populations such as wholegrains, some fruit, green leafy vegetables, yogurt and cheese, tea and coffee	1

• Reduce specific foods associated with increased risk in general populations including red and processed meat, potatoes, particularly French fries, sugar sweetened beverages and refined carbohydrates • Offer culturally tailored, multi-component lifestyle interventions to reduce the risk of Type 2 diabetes in ethnic minority groups	2 2 3

Weight management and remission of Type 2 diabetes

RECOMMENDATIONS	Evidence GRADE
• For overweight or obese people with Type 2 diabetes ▪ For Type 2 diabetes remission, aim for weight loss of approximately 15kg, as soon as possible after diagnosis ▪ To improve glycaemic control and CVD risk, aim for at least 5% weight loss achieved by reducing calorie (energy) intake and increasing energy expenditure • Adopt an individualised approach which may include dietary, physical activity, surgical and medical strategies that are recommended for people without diabetes	3 4 NR

Glycaemic control and Type 1 diabetes

RECOMMENDATIONS	Evidence GRADE
• Offer education to support people with Type 1 diabetes to identify and quantify their dietary carbohydrate intake for glycaemic control. Specifically: ▪ Adjust insulin to carbohydrate intake in people using multiple daily injections (MDI) and continuous subcutaneous insulin infusion (CSII) (insulin pump) ▪ Aim for consistent quantities of carbohydrates on a day-to-day basis in people on fixed insulin regimens	4 1

Glycaemic control and Type 2 diabetes

RECOMMENDATIONS	Evidence GRADE
• Prioritise weight loss of at least 5% in overweight people by reducing calorie (energy) intake and increasing energy expenditure	4
• Aim for a Mediterranean-style diet or equivalent healthy eating pattern (see CVD section)	4
• Offer individualised education to support people to identify and quantify their dietary carbohydrate intake, encourage low glycaemic index (GI) foods and consider reducing the total amount of carbohydrates	3
• Aim for at least 150 mins per week of moderate to vigorous physical activity, over at least three days	4

Cardiovascular disease- blood lipids and blood pressure

RECOMMENDATIONS	Evidence GRADE
• Dietary patterns, specifically the Mediterranean and DASH-style diets, are recommended to reduce CVD risk factors and CVD events in people with diabetes. Key features of these diets include: ▪ Decrease salt intake (<6g/day) ▪ Eat two portions of oily fish each week ▪ Eat more wholegrains, fruit and vegetables, fish, nuts and legumes (pulses) ▪ Eat less red and processed meat, refined carbohydrates and sugar sweetened beverages ▪ Replace saturated fats (SFA) with unsaturated fats, and limit intakes of trans fatty acids (TFA) ▪ Limit alcohol intake to <14 units a week	3
• Aim for modest weight loss of at least 5% in overweight individuals	3
• Aim for at least 150 mins per week of moderate to vigorous physical activity, over at least three days.	4
• Products containing 2-3g of plant stanols and sterols per day can be recommended	3

Nutritional management of diabetes complications

Hypoglycaemia

RECOMMENDATIONS	Evidence GRADE
• An individualised approach to hypoglycaemia management with appropriate monitoring is recommended. One example of a strategy commonly recommended is: ▪ Take 15–20g glucose ▪ Repeat treatment if blood glucose level has not risen above 4mmol/l after 15 minutes ▪ Depending on individual needs and treatment, a follow-up snack providing 15–20g carbohydrate may be necessary	NR

Diabetic nephropathy

RECOMMENDATIONS	Evidence GRADE
• Offer individualised approach to minimise risk of malnutrition: ▪ Provide advice on potassium, phosphate, salt and energy intake as clinically required ▪ Do not routinely restrict protein intake	NR

Lower limb ulcers and amputations

RECOMMENDATIONS	Evidence GRADE
• Assess nutritional status and offer individualised approach to minimise malnutrition, and optimise glycaemic control	NR

Diabetic gastroparesis

RECOMMENDATIONS	Evidence GRADE
• Offer individualised care to meet nutritional requirements, manage symptoms and optimise glycaemic control	NR

Other special considerations

Nutrition support

RECOMMENDATIONS	Evidence GRADE

• Aim to meet nutritional requirements and adequacy
  ▪ Adjust diabetes treatment to optimise glycaemic control
  ▪ Deliver support from a multi-disciplinary team
	2

• General enhanced recovery after surgery protocols can be recommended, depending on individual clinical situation.	NR
• Diabetes specific formulae enteral feeds can be recommended, but are not routinely used in the UK	2

Older people with diabetes

RECOMMENDATIONS	Evidence GRADE
• Offer education, including dietary intervention, to older people with diabetes. Age should not restrict access to education	4
• Assess nutritional status and care plans under the supervision of a dietitian	NR
• Adapt general guidelines for people with diabetes for those with dementia	NR

Diabetes care in institutions

RECOMMENDATIONS	Evidence GRADE
• Offer access to education, including dietary intervention, to people in institutions	**NR**
• Provide menus with nutritional information, including carbohydrate content	**1**

Pregnancy

RECOMMENDATIONS	Evidence GRADE
Women living with diabetes (both Type 1 and Type 2 diabetes) prior to conception should : • Receive support from a multidisciplinary team, including referral to a dietitian	NR

• Aim to achieve and maintain optimal glycaemic control before and during pregnancy • Aim to lose weight before pregnancy if overweight or obese and maintain appropriate weight gain during pregnancy • Take 5mg folic acid/day before pregnancy until the end of the 12th week of pregnancy Women diagnosed with gestational diabetes should: • Be referred to a dietitian for dietary advice • Aim to achieve appropriate weight gain • Take regular physical activity, including walking for 30 minutes after a meal to lower postprandial glucose concentrations	NR

Coeliac disease

RECOMMENDATIONS	Evidence GRADE
• Offer individualised advice by a specialist dietitian to all people with coeliac disease and diabetes. • Recommend adherence to a gluten free diet	NR 4

Cystic fibrosis related diabetes mellitus (CFRD)

RECOMMENDATIONS	Evidence GRADE
• Provide individualised dietary and insulin education and advice to optimise nutritional status, weight and glycaemic control • Avoid unnecessary dietary energy restrictions • Provide education to support people to identify and quantify carbohydrates to manage glycaemic control, including during supplementary feeding.	NR 1 1

Diabetes in HIV

RECOMMENDATIONS	Evidence GRADE
• Offer individualised multi-component interventions to treat antiretroviral-associated weight gain to reduce risk of Type 2 diabetes	NR

• Follow diet and physical activity recommendations for the general diabetes population to manage diabetes in people with HIV	NR

Eating disorders

RECOMMENDATIONS	Evidence GRADE
• Consider the possibility of disordered eating or other control behaviours relating to food in adults with diabetes	NR
• Use suitable screening tools to identify possible eating disorders at the earliest opportunity.	2
• Consider an early referral to local eating disorder services	NR

Micronutrients, food supplements and functional foods

RECOMMENDATIONS	Evidence GRADE
• Do not recommend micronutrient supplementation to manage or prevent diabetes	4
• Encourage individuals choosing to use supplements to discuss their individual needs with a registered dietitian	NR

Diabetic foods, sugars and other sweeteners

RECOMMENDATIONS	Evidence GRADE
• Avoid food labelled ‘diabetic’ or ‘suitable for diabetics’	NR
• Reduce intake of free sugars, sugar-sweetened beverages, added fructose and polyols.	2
• Non-nutritive (artificial) sweeteners are safe and may be recommended	NR

Appendix B – The Grading of Recommendations Assessment, Development and Evaluation (GRADE) scoring for quality of evidence

The highest score for a clinical recommendation according to GRADE is 4, and lower numbers denote deductions made for lower-quality studies with limited generalisability; see below:

- Grade 4: strong recommendation based on high quality evidence
- Grade 3: moderate recommendation based on moderate quality evidence
- Grade 2: low strength recommendation based on low quality evidence
- Grade 1 (or less): very low strength recommendation based on very low quality evidence

RCTs, systematic reviews and meta-analyses of RCTs were graded 4 and observational cohort studies were graded 2. The quality of data was then assessed, and up to 3 points were deducted according to issues such as small studies (less than 100 participants), heterogeneity of intervention, follow-up, attrition and incomplete reporting. Further points were deducted according to the consistency of effects between studies, with 1 point deducted for lack of agreement. The generalisability of the population and translating outcomes from studies to the population of interest was also considered, and 1 point was deducted for each component of difference. For example, the majority of studies for cardiovascular disease (CVD) prevention were performed in general populations rather that in people with diabetes. Cost-effectiveness and effect size were not considered in this adapted grading system. A flow chart is shown below to indicate the grading used in these guidelines.

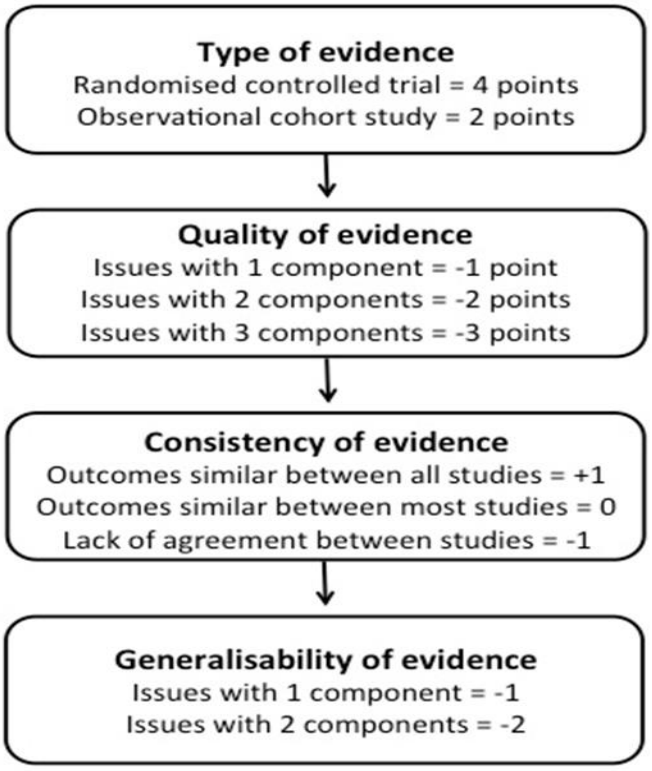

Fig 1. Flow-chart of grading system

Not Rated (NR)

A key aspect of current approaches to supporting people with diabetes is to encourage practice that is individualised. It is challenging to rate such recommendations using the GRADE system, particularly in situations where multiple conditions influence health and dietary approaches. In response to this, a deliberate decision was made to report these recommendations as 'Not Rated', indicated by the letters NR.

This approach was used for three different circumstances:

- Firstly, for qualitative guidelines recommending individualised interventions and treatment, as these are not captured within recognised strategies such as RCTs.
- Secondly, some national and international guidance (e.g. NICE and SACN) are not assessed by the GRADE system, or do not assign a GRADE number and have been designated NR.
- Thirdly, NR was applied where there was no evidence specifically for people with diabetes and where it was clinically reasonable to extrapolate from data collected from general populations.

It is important to stress that an NR score for a particular recommendation does not mean that the recommendation was based on weak evidence. Some of the recommendations rated NR were based on meta-analyses, systematic reviews and RCTs.