Clinical Practice GUIDELINE for the Management of Obesity in Adults in Ireland

Medical Nutrition Therapy in Obesity Management

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KEY MESSAGES FOR HEALTHCARE PROFESSIONALS

- **Healthy eating is important for all of the Irish population, regardless of body size, weight or health status.** The Irish healthy eating guidelines can be used as a resource for nutrition- and food-related guidance for the general population.
- **Use evidence-based nutrition resources to give your patients nutrition advice that aligns with their values, preferences, and social determinants of health** (Figure 1).
- **There is no one-size-fits-all eating pattern for obesity management. Adults living with obesity may consider various nutrition intervention options that are client-centred and flexible.** Evidence suggests this approach will better facilitate long-term adherence (Table 1, Figure 2). Consideration should be given to flexibly synergising beneficial elements of various nutrition approaches with a focus on health outcomes.
- **Nutrition interventions for obesity management should incorporate the concept of "best weight", focus on achieving health outcomes, meeting individualised nutrition requirements and quality of life improvements, not just weight changes.** Table 2 outlines health-related outcomes to support patients/clients in obesity management.
- **Nutrition interventions for obesity management should emphasise individualised eating patterns, food quality and a healthy relationship with food.** Interventions that help improve awareness of hunger and satiety, lower food cravings and reduce reward-driven eating and may be important.
- **Caloric restriction can achieve short-term reductions in weight (i.e., < 12 months) but has not shown to be sustainable long term (i.e., > 12 months).** Caloric restriction may affect neurobiological pathways that control appetite, hunger, cravings, and body-weight regulation that may result in increased food intake and weight gain.

KEY MESSAGES FOR HEALTHCARE PROFESSIONALS - Continued

- **People living with obesity are at increased risk for micronutrient deficiencies including but not limited to vitamin D, vitamin B_{12} and iron deficiencies.** Restrictive eating patterns and obesity treatments (e.g., medications, bariatric surgery) may also result in micronutrient deficiencies and malnutrition. Assessment including biochemical values can help inform recommendations for food intake, vitamin/mineral supplements, and possible drug-nutrient interactions.

- **Collaborative care with a dietitian registered with CORU, the authority responsible for the regulation of health and healthcare professionals in Ireland, who has experience in obesity management and medical nutrition therapy is recommended.** Registered dietitians (RDs) can support people living with obesity who also have other chronic diseases, malnutrition, food insecurity or disordered patterns of eating. The representative body for Irish RDs is the Irish Nutrition and Dietetic Institute (www.indi.ie).

- **Future research should use nutrition-related outcomes and health behaviours in addition to weight and body-composition outcomes.** Characterisation of population sample collections should use the updated definition of obesity as "a complex chronic disease, characterised by abnormal or excessive body fat (adiposity), that impairs health," rather than body mass index (BMI) exclusively. Qualitative data is needed to better understand the lived experience of people with obesity and how that relates to nutrition and eating behaviours.

RECOMMENDATIONS

1. We suggest that nutrition recommendations for adults of all body sizes should be personalised to meet individual values, preferences and treatment goals to support a dietary approach that is safe, effective, nutritionally adequate, culturally acceptable, affordable and enjoyable for long-term adherence (Level 4, Grade D)[1].

2. Adults living with obesity should receive individualised medical nutrition therapy provided by a dietitian registered with CORU, the authority responsible for the regulation of health and healthcare professionals in Ireland (when available) to improve health outcomes, including weight (body weight, body mass index), waist circumference (WC), glycaemia, lipids and blood pressure (BP) (Level 1a, Grade A)[2].

3. Adults living with obesity and impaired glucose tolerance (pre-diabetes) or type 2 diabetes mellitus (T2DM) may receive medical nutrition therapy provided by a CORU registered dietitian (when available) to improve glycaemia and BP and reduce body weight and WC (Level 2a, Grade B)[3,4].

4. Adults living with obesity can consider any of the multiple medical nutrition therapies to improve health-related outcomes, choosing the dietary patterns and food-based approaches that support their best long-term adherence:

    a. Calorie-restricted dietary patterns emphasising variable macronutrient distribution ranges (lower, moderate, or higher carbohydrate with variable proportions of protein and fat) to achieve similar body weight reduction over six to 12 months (Level 2a, Grade B)[5].

    b. Mediterranean dietary pattern to improve glycaemia, high density lipoprotein cholesterol (HDL-C) and triglycerides (Level 2b, Grade C)[6]; reduce cardiovascular events (Level 2b, Grade C)[7]; reduce risk of T2DM (Level 2b, Grade C)[8,9] and increase reversion of metabolic syndrome (Level 2b, Grade C)[10] with little effect on body weight and WC (Level 2b, Grade C)[11].

    c. Vegetarian dietary pattern to improve glycaemia, established blood lipid targets including low density lipoprotein cholesterol (LDL-C), and reduce body weight, (Level 2a, Grade B)[12], risk of T2DM (Level 3, Grade C)[13] and coronary heart disease incidence and mortality (Level 3, Grade C)[14].

    d. Portfolio dietary pattern to improve established blood lipid targets including LDL-C, apolipoprotein B (apo B) and non-HDL-C (Level 1a, Grade B)[15], C-reactive protein (CRP), BP and estimated 10-year coronary heart disease risk (Level 2a, Grade B)[16].

    e. Low-glycaemic index dietary pattern to reduce body weight (Level 2a, Grade B)[16], glycemia (Level 2a, Grade B)[17], established blood lipid targets including LDL-C (Level 2a, Grade B)[18], and BP (Level 2a, Grade B)[19], and the risk of T2DM (Level 3, Grade C) 20 and coronary heart disease (Level 3, Grade C)[21].

    f. Dietary Approaches to Stop Hypertension (DASH) dietary pattern to improve BP (Level 2a, Grade B)[22], established lipid targets including LDL-C (Level 2a, Grade B)[22], CRP (Level 2b, Grade B)[23], glycaemia (Level 2a, Grade B)[22], reduce the risk of T2DM, cardiovascular disease (CVD), coronary heart disease and stroke (Level 3, Grade C)[22], and to reduce body weight and WC (Level 1a, Grade B)[24].

g. Nordic dietary pattern to improve BP (Level 2b, Grade B)[25] and established blood lipid targets, including LDL-C, apo B, (Level 2a, Grade B)[26], non-HDL-C (Level 2a, Grade B)[27], reduce the risk of cardiovascular and all-cause mortality (Level 3, Grade C)[28], and reduce body weight (Level 2a, Grade B)[29] and body weight regain (Level 2b, Grade B)[25].

h. Partial meal replacements (replacing one to two meals/day as part of a calorie-restricted intervention) to reduce WC, BP, body weight and improve glycaemia (Level 1a, Grade B)[30].

i. Intermittent or continuous calorie restriction achieved similar short-term body weight reduction (Level 2a, Grade B)[31].

j. Pulses (i.e., beans, peas, chickpeas, lentils) improve glycaemia (Level 2, Grade B)[32], established lipid targets including LDL-C (Level 2, Grade B)[33], systolic BP (Level 2, Grade C)[34], reduce the risk of coronary heart disease (Level 3, Grade C)[35] and to improve body weight (Level 2, Grade B)[36].

k. Vegetables and fruit to improve diastolic BP (Level 2, Grade B)[37], glycemia (Level 2, Grade B)[38], reduce the risk of type 2 diabetes (Level 3, Grade C)[39] and cardiovascular mortality (Level 3, Grade C)[40].

l. Nuts to improve glycaemia (Level 2, Grade B)[41], established lipid targets including LDL-C (Level 3, Grade C)[42] and reduce the risk of CVD (Level 3,Grade C)[43].

m. Whole grains (especially from oats and barley) to improve established lipid targets including total cholesterol and LDL-C (Level 2, Grade B)[44].

n. Dairy foods to reduce the risk of type 2 diabetes and CVD (Level 3, Grade C)[39] and to reduce body weight, WC, body fat and increase lean mass in calorie-restricted diets but not in unrestricted diets (Level 3, Grade C)[45].

5. Adults living with obesity and impaired glucose tolerance (pre-diabetes) should consider intensive interventions that target a 5% – 7% weight loss to improve glycaemia, BP and blood lipid targets (Level 1a, Grade A)[46], reduce the incidence of T2DM (Level 1a, Grade A)[47], microvascular complications (retinopathy, nephropathy and neuropathy) (Level 1a Grade B)[48] and cardiovascular and all-cause mortality (Level 1a, Grade B)[48].

6. Adults living with obesity and T2DM should consider intensive interventions that target a 7% – 15% weight loss to increase the remission of T2DM (Level 1a, Grade A)[49] and reduce the incidence of nephropathy (Level 1a, Grade A)[50], obstructive sleep apnoea (Level 1a, Grade A)[51] and depression (Level 1a, Grade A)[52].

7. We recommend non-restrictive approaches to improve quality of life, psychological outcomes (general wellbeing, body image perceptions), cardiovascular outcomes, body weight, physical activity, cognitive restraint and eating behaviours (Level 3, Grade C)[53].

KEY MESSAGES FOR PEOPLE LIVING WITH OBESITY

- **Nutrition is important for everyone, regardless of body size or health. Your health is not a number on a scale.** If you're thinking about making a change to the way you eat, choose eating goals that improve overall nutrition and health (medical, functional, emotional health) (Table 2).

- **There is no one-size-fits-all healthy eating pattern. Choose an eating pattern that supports your best health and one that can be maintained over time, rather than a short-term "diet".** Talk to a healthcare professional (HCP) to discuss the advantages and disadvantages of different eating patterns to help achieve your health-related goals. How you eat is as important as what and how much you eat. Practice eating mindfully and build a healthy relationship with food.

- **Severely restricting the amount you eat may mean you miss out on important nutrients for health and may cause changes to your body that lead to weight regain over time.** If you're thinking about these approaches, you should discuss this with a HCP.

- **See a dietitian registered with CORU, the authority responsible for the regulation of health and healthcare professionals in Ireland, for an individualised approach and ongoing support for your nutrition and health-related needs.** The representative body for Irish registered dietitians is the Irish Nutrition and Dietetic Institute (www.indi.ie).

Introduction

People living with obesity[54] and people with larger bodies are often stigmatised and scrutinised for their food choices, portions and eating behaviours[54-56]. Much of the social marketing efforts, public health and clinical messaging around food and eating behaviours has focused on "eating less" or choosing "good" foods. As a result of these messages, dieting and weight loss-focused outcomes perpetuate the notion that weight loss and/or "health" can be achieved purely by caloric restriction, food deprivation and/or "dieting" practices. These simplistic narratives often neglect the evidence that weight loss may not be sustainable long term, not because of personal choices or lack of willpower, but rather from strong biological or physiological mechanisms that protect the body against weight loss and promote weight regain. The diet industry and weight loss-focused research field has thus falsely advertised diet or food and eating habits as the culprit for weight gain, contributing to the bias and stigma reviewed in Chapter 1 Reducing Weight Bias in Obesity Management Practice and Policy. A paradigm shift is needed in all aspects of nutrition and eating behaviour research, policies, education, and health promotion to support people of all weights, body shapes and sizes to eat well without judgement, criticism or bias regarding food and eating behaviours.

This chapter provides evidence-informed information on nutrition interventions conducted in clinical and/or epidemiological studies in the context of obesity management for adults. This chapter does not cover peri-operative bariatric nutrition - please see Chapter 12 Bariatric Surgery: Selection and Preoperative Work-up and Chapter 14 Bariatric Surgery: Postoperative Management. Definitions used in this chapter are summarised in Appendix 1. Caution is needed when interpreting much of the nutrition-specific evidence, as weight loss is often a primary outcome in nutrition-related studies, and most studies have used the definition of obesity according to body mass index (BMI) classifications instead of the current definition as a complex chronic disease, characterised by dysfunctional or excess body fat (adiposity), that impairs health[57]. Recommendations and key messages in this chapter are specific for people living with obesity and may not be applicable or appropriate for people with larger bodies who do not have weight-related health complications. Furthermore, this chapter provides guidance for healthcare professionals (HCPs) to support coordination of care with regulated clinical nutrition professionals in Ireland (i.e., dietitians registered with CORU, the authority responsible for the regulation of health and healthcare professionals in Ireland).

Traditional nutrition interventions for obesity have focused on strategies that promote weight loss through dietary restriction. Although a caloric deficit is required to initiate weight loss, sustaining lost weight may be difficult long term due to compensatory mechanisms that affect metabolism and promote positive calorie intake by increasing hunger hormones and the drive to eat[58-60]. HCPs, policy makers, patients/clients and the general public should be aware that nutrition interventions affect everyone differently, and therefore there is no one best nutrition approach or intervention[61]. As such, some people may favour an approach that is macronutrient-based (consisting of higher, moderate, or lower intake of carbohydrates, protein and/or fat), caloric restricted, food-based or non-restrictive. Nutrition and healthy eating are important to the health and wellbeing of all people living in Ireland, regardless of weight, body size or health status.

In Ireland, the National Adult Nutrition Survey (NANS) has shown that a Western-style pattern predominates in the general adult population[62]. Fruit/vegetable and fibre intake is low, salt and saturated fat intake is high and there are inadequate intakes of some micronutrients, including calcium and vitamin D[62,63]. This reflects the supply chain in a Western-style food environment which is estimated to supply over 3,500 kilocalories per capita per day[64]. Eating or changing eating to a pattern which requires careful navigation around convenient, inexpensive, higher-energy foods in the current food environment presents a challenge to the population as a whole. Chapter 4 Prevention and Harm Reduction of Obesity (Clinical Prevention) summarises the ongoing work in Ireland to modify the wider food environment and "make the healthier choice the easier choice". Also, food fills more than simply biological needs. It can be a source of both pleasure and anxiety, and it plays a vital role in how humans communicate within their social world where it is used to establish affiliation, engender acceptance and express love, power, hospitality and social status[65]. These considerations need to be incorporated into medical nutrition therapy (MNT) when counselling individuals with all conditions, including obesity.

In the context of obesity management, the best nutrition approach is one an individual can maintain long term to achieve health-related and weight-related outcomes[5]. Table 1 and Figure 2 provide an overview of the various nutrition interventions used to influence health outcomes, weight change, quality of life (QoL) indicators, as well as the advantages and disadvantages of each.

Individualised Medical Nutrition Therapy

Nutrition interventions should use a shared decision-making approach to improve overall health, promote a healthy relationship with food, consider the social context of eating and promote eating behaviours that are sustainable and realistic for the individual. A CORU registered dietitian (RD) should be involved in the assessment, delivery and evaluation of care wherever possible. MNT provided by a RD has demonstrated improvements in glycaemia, reductions in low density lipoprotein cholesterol (LDL-C), triglycerides and blood pressure (BP), weight outcomes (body weight and BMI) and waist circumference (WC)[2-4].

The Health Service Executive (HSE) Model of Care for the Management of Overweight and Obesity, launched in 2021, describes healthcare services required for people living with obesity in Ireland and how those services should be organised, delivered, and resourced across the healthcare system. It recommends access to RDs in ambulatory care hubs and in specialist obesity multi-disciplinary teams (MDTs) to support evidence-based MNT and behavioural interventions which may be delivered individually, in groups and using telehealth platforms[66]. A recent survey of dietetic management of obesity

among European RDs showed inconsistencies in the approaches used and recommended that clinical guidelines were needed in this area to support dietetic practice[67].These adapted Irish guidelines can support RDs working at all levels of the Model of Care with the delivery of best-practice MNT interventions.

Systematic reviews and meta-analyses of randomised controlled trials (RCTs) have shown that individualised MNT by a RD resulted in significant reductions of glycated haemoglobin (HbA1c), cholesterol, systolic BP, weight, BMI and WC in adults living with type 2 diabetes mellitus (T2DM)[4] and decreases weight by an additional 1.03 kg and BMI by -0.43 kg/m^2 in participants with BMI ≥ 25 kg/m^2 compared with usual care or written documentation[2]. In addition, MNT delivered by a RD to individuals and/or group-based sessions for the prevention of T2DM has also found a weight loss range of -1.5 kg to -13 kg (3% – 26% weight loss) with a pooled effect of -2.72 kg by meta-analysis 3. Irish data shows similar outcomes of a mean reduction of 1.8 (SD 1.7) kg in 184 individuals attending a six-week RD-led group-based weight-focused intervention (Programme for Healthy Eating and Weight Management (PHEW) in a Level 2 community setting[68]. A dietetic-led community-based T2DM self-management programme (Diabetes Education and Self-Management Programme (DESMOND)) also saw an improvement in HbA1c of 5.7 ± 15 mmol/mol and weight loss of 1.4 ± 4.4 kg[69]. A key role for the RD in individualised MNT is integrating therapeutic dietary requirements for obesity care with associated complications that may in themselves have specific nutrition recommendations e.g., T2DM, renal or liver disease or sarcopenia.

Table 1 provides outcomes measures for health, QoL and weight parameters when using individualised MNT by a RD.

Nutrition care process

The nutrition care process (NCP) is recommended as a structure that offers RDs a standardised process and language by which to document nutrition assessment, nutrition diagnosis, nutrition intervention and monitoring within clinical nutrition care[70-72]. RDs in Ireland can seek training and more information about NCP via the Irish Nutrition and Dietetic Institute (www.indi.ie). The NCP is a template for all clinical conditions. Standardised language for developing nutrition diagnoses (problem, aetiology, signs and symptoms [PES] statements) may not reflect the breadth of complexities now aligned with obesity as a chronic disease. Nevertheless, the framework is useful for structuring a comprehensive assessment and planning an MNT intervention for obesity in a similar manner to other diseases. Appendix 2 Table 4 details an assessment and diagnosis template table modelled on NCP with key considerations for obesity care.

Nutrition interventions

Nutrition interventions that are safe, effective, nutritionally adequate, culturally acceptable, affordable and enjoyable for long-term adherence should be considered for adults living with obesity[1]. HCPs should adapt nutrition interventions and adjunctive therapy to meet their patients'/clients' individual values, preferences and treatment goals. Consideration should be given to flexibly synergising beneficial elements of various nutrition approaches with a focus on health outcomes. To date, no single best nutrition intervention has been shown to sustain weight loss long term, and literature continues to support the importance of long-term adherence, regardless of the intervention[5,73].

Caloric restriction

Studies on caloric restriction generally fall into three categories: moderate calorie (1,300 kcal/day – 1,500 kcal/day), low calorie (900 kcal/day – 1,200 kcal/day) and very-low calorie (< 900 kcal/day), with intervention periods ranging from three months to three years.

A randomised clinical trial of women (25 – 75 years old) with BMI 37.84 +/- 3.94 kg/m^2 found prescribing 1,000 kcal/day versus 1,500 kcal/day along with behavioural treatment produced greater weight loss at six months, but there was significant weight regain at 12 months as compared with the 1,500 kcal/day group[74]. At 12 months, a significantly greater percentage of participants prescribed 1,000 kcal/ day had body weight reductions of 5% or more than those assigned 1,500 kcal/day[74]. However, a 1,000 kcal/ day prescription may be more difficult to sustain, especially for individuals for whom the caloric reduction is 50% or more from their usual intake[74].

A randomised clinical trial of older adults (≥ 65 years old) who were advised to reduce their caloric intake by 500 kcal/day below their estimated caloric needs with a minimum intake of 1,000 kcal/day had significant improvements in BP and high density lipoprotein cholesterol (HDL-C) in addition to a decrease in body weight (4%) at 12 month [75].

A systematic review and meta-analysis of RCTs using very low-calorie diets (VLCD), with or without meal replacements, for weight loss found using a VLCD within a behavioural weight-loss programme produced greater weight loss at 12 months (-3.9 kg) and 24 months (1.4 kg) than a behavioural programme alone[76]. There was no evidence a VLCD intervention without behavioural support is effective[76].

Although MNT that achieves a caloric deficit can result in weight loss in the short term (six to 12 months), the weight change is often not sustained over time. Furthermore, the common recommendation that a caloric deficit of 500 kcal/day or 3,500 kcal/week would produce 1 lb (0.45 kg) of weight loss is not valid, in that weight loss is not linear[77,78]. Polidori and colleagues first quantified the amount of calorie intake compensated for weight-loss changes in free living humans and estimated that appetite increased by ~100 kcal/day for every kilogram of weight lost, contributing to weight gain over time[79]. Caloric restriction may lead to pathophysiological drivers to promote weight gain via increased hunger, appetite and decreased satiety[60]. In addition, caloric restrictions may have negative consequences for skeletal health[80] and muscle strength[81]. Caloric restriction as part of MNT in obesity should consist of individualised

interventions to ensure it is safe and effective and that it matches the values and preferences of the patient/client. Indirect calorimetry should be considered if energy expenditure and/or caloric targets are indicated[82]. In clinical practice in Ireland, indirect calorimetry is rarely available and so the use of predictive energy equations may need to be considered. There are limitations to the use of such equations, and no single predictive equation provides accurate and precise estimates in all adults with obesity. A recent UK systematic review reaffirmed the Mifflin St Jeor equation as the most accurate in determining resting metabolic rate (RMR) in this population[83]. As part of MNT, it's important that RDs recognise that calculations for RMR as part of a calorie-restricted plan are not precise and only provide a starting point for discussions about energy needs - monitoring and adjustments will be important depending on the patient's response to treatment[84].

Calorie restriction in older adults

The Food Safety Authority of Ireland (FSAI) advise caution in relation to weight loss and caloric restriction in older adults[85]. Weight loss, whether intentional or not, enhances the age-related loss of muscle mass, and consequently increases the risk of sarcopenia, frailty, functional decline, fractures, and malnutrition[86]. Older adults with obesity should be individually assessed (including functional resources, metabolic risk, comorbidities, the individual's perspective and priorities and estimated effects on his or her QoL) to consider the potential impact of a weight-loss diet. Where a weight-loss diet is deemed to be beneficial, energy restriction should be moderate in order to achieve slow weight loss and preserve muscle mass[85]. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends maintaining a minimum intake of 1,000 kcal/day – 1,200 kcal/day, a protein intake of at least 1 g/kg body weight (BW)/ day and an appropriate intake of micronutrients[86]. Diets with very low energy intakes (< 1,000 kcal/day) are discouraged due to the risk of developing malnutrition and promoting functional decline. In this population, dietary interventions should be combined with physical activity where possible to prevent loss of muscle mass and accompanying functional decline[85].

Macronutrient-based approaches

Macronutrients are the main source of calories in the diet. The dietary reference intakes (DRIs) are a comprehensive set of nutrient reference values for healthy populations that can be used for assessing and planning eating patterns. (For more information, refer to: https://multimedia.efsa.europa.eu/drvs/index.htm). The DRIs describe wide acceptable macronutrient distribution ranges - for example, 45% to 65% of calories from carbohydrate, 10% to 35% of calories from protein and 20% to 35% of calories from fat (with 5% to 10% of calories derived from linoleic acid and 0.6% to 1.2% of calories derived from alpha linolenic acid)[87].

Several macronutrient-based approaches have been investigated within and outside these ranges. Researchers have evaluated, for instance, low-carbohydrate diets that substitute fat and protein at the expense of carbohydrate but include adequate protein (15% – 20% of calories). Studies have also investigated extremely low-carbohydrate (≤ 10% of calories) variants, including variants like the ketogenic diet which are extremely high in fat (≥ 75% of calories). No meaningful long-term advantages of one macronutrient distribution over another have reliably been shown.

A network meta-analysis was undertaken of 48 RCTs (involving 7,286 participants) that provided dietary advice to consume varying macronutrient distributions under free-living conditions. This meta-analysis showed no differences in weight loss at six months and 12 months of follow-up between diets categorised broadly by their macronutrient distribution as low carbohydrate, moderate macronutrient or low fat, or categorised by their 11 popular diet names encompassing a wide range of distributions 5. Subsequent large RCTs and a recent meta-analysis have confirmed these findings[88,89].

The lack of meaningful differences between different macronutrient distributions has been shown to extend to longer-term cardiometabolic outcomes. Systematic reviews and meta-analyses of randomised trials have investigated glycaemia in people with T2DM (inclusive of people with BMI ≥ 25 kg/m^2). These trials have shown that the short-term improvements seen in glycaemia at six months are not sustained at 12 months on low-carbohydrate diets (≤ 40% of calories from carbohydrate or 21 g – 70 g) in which the carbohydrate has been replaced with fat and/or protein[90]. Researchers have also assessed the effects of low-carbohydrate diets that replace carbohydrate with protein in people with or without T2DM who have a BMI ≥ 25 kg/m^2. They report a similar attenuation of effects on fasting blood glucose and triglycerides and lack of effect on BP and C-reactive protein (CRP) over follow-up periods that extend beyond 12 months[91]. Any improvements in triglycerides and HDL-C have also been found to come at the expense of increases in the more atherogenic and established lipid targets for cardiovascular risk reduction, LDL-C, non-HDL-C and apolipoprotein B (apo B)[90,92]. According to available RCTs, the most important determinants of achieving any benefit over the long term are adherence to any one macronutrient distribution and clinic attendance[5,91,93,94].

These data from RCTs are supported by evidence from large prospective cohort studies that allow long-term macro-nutrient exposures to be assessed in relation to downstream clinical outcomes of cardiometabolic diseases. The Atherosclerosis Risk in Communities (ARIC) and the Perspective Urban Rural Epidemiology (PURE) cohort studies showed that no single approach appears superior. There may be potential harms observed at the extremes of intake with a U-shaped relationship between carbohydrate and mortality at < 40% and > 70% of energy[95,96].

The quality of the macronutrients substituted appears to be an equally if not more important consideration than the quantity. The Eco-Atkins randomised trial showed that a lower-carbohydrate intervention (26% of total calories) reduced LDL-C in 47 participants with BMI > 27 kg/ m^2 and hyperlipidaemia over four weeks, during which foods were provided, and another six months during which

foods were self-selected[97,98]. This intervention replaced refined, high-glycaemic index carbohydrate sources with high-quality unsaturated fat from nuts and canola oil and plant-based protein from soy and pulses.

Systematic reviews and meta-analyses of RCTs of interventions that focus on the quality of the fat or protein separately have also shown advantages. Researchers have investigated isocaloric replacement of refined carbohydrate sources with high-quality monounsaturated fatty acids (MUFAs) from canola oil and olive oil[99] or animal protein with sources of plant-based protein[100,101]. These studies have shown improvements in multiple cardiometabolic risk factors in people with T2DM and a BMI ≥ 25 kg/m^2, over average follow-ups of 19 weeks and eight weeks, respectively[99]. Similarly, dairy whey protein supplements substituted for largely other protein sources and/or carbohydrate have shown reductions in body weight and fat mass, and improvements in BP, blood glucose and blood lipids over follow-up ranging from 2-15 months in people with BMI ≥ 25 kg/m^2 [102]. Other systematic reviews and meta-analyses of randomised cardiovascular outcomes trials have shown that the beneficial effect of low saturated fatty acids (SFAs) diets on cardiovascular events is restricted to the replacement of saturated fatty acids with polyunsaturated fatty acids[103], especially mixed n-3/n-6 sources, such as soybean oil and canola oil[104,105].

The importance of the quality of the macronutrients has been seen in the observational evidence from prospective cohort studies which suggest that replacement of SFAs with high-quality sources of MUFAs (from olive oil, canola oil, avocado, nuts and seeds), high-quality sources of carbohydrates (from whole grains and low-glycaemic index carbohydrate foods) and plant-based unsaturated fats and protein is associated with decreased incidence of coronary heart disease[106,107]. An analysis of the PURE study showed that the source of carbohydrate may modify the association, with the highest intake of carbohydrate from sources such as legumes and fruit being associated with lower cardiovascular mortality and all-cause mortality[108].

Taken together, the available evidence related to macronutrients suggests that there is a wide range of acceptable intakes, emphasising the role of individualised MNT. The data also suggest that quality may be an equally if not more important focus than quantity in the evaluation of the relationship between macronutrient distributions and cardiometabolic outcomes. This theme is reflected in the subsequent discussions of dietary patterns and food-based approaches.

Dietary fibre

High intakes of dietary fibre are recommended for the general population. The European Food Safety Authority (EFSA) dietary reference values have set an adequate intake for total fibre from naturally occurring, added or supplemental sources of 25 g/day for adults > 18 years[109]. In Ireland, intakes of dietary fibre fall short of these recommendations, with mean daily intakes of 19 g per day[110].

Several advantages have been shown for optimal dietary fibre intakes. The World Health Organization (WHO) commissioned a series of systematic reviews and meta-analyses of prospective cohort studies, inclusive of people without acute or chronic diseases (including individuals with pre-diabetes, mild to moderate hypercholesterolaemia, mild to moderate hypertension or metabolic syndrome). The evidence showed that higher intakes of total dietary fibre were associated with decreased incidence of T2DM, coronary heart disease and mortality, stroke and mortality, colorectal cancer, and total cancer and mortality. Differences were not observed in risk reduction by fibre type (insoluble, soluble or soluble viscous) or fibre source (cereals, fruit, vegetables or pulses)[111]. Meta-regression dose response analyses showed that benefits were associated with intakes greater than 25 g – 29 g per day[111]. Similar results have been shown in systematic reviews and meta-analyses of prospective cohort studies that did not exclude people with T2DM[112].

Despite the lack of interaction by fibre type and source in the prospective cohort studies, the evidence from RCTs differs. This data supports the benefits of dietary fibre on intermediate cardiometabolic risk factors and suggests these are restricted largely to fibre from a soluble viscous fibre. The European Commission has authorised the use of the health claim "barley beta-glucans has been shown to lower/reduce blood cholesterol"[113].

Systematic reviews and meta-analyses of RCTs have evaluated specific types of soluble viscous fibre. The evidence from oats (beta-glucan), barley (beta-glucan), psyllium, konjac mannan (glucomannan) and fruit and vegetables (pectin) shows improved glycaemia by HbA1c and fasting blood glucose, insulin resistance by homeostatic model assessment for insulin resistance (HOMA-IR), BP and blood lipids, including the established therapeutic lipid targets LDL-C, non-HDL-C and apo B[114-119]. The studies also highlighted that insoluble fibre, other than contributing to stool bulking[120], has not shown cardiometabolic advantages in comparison with low-fibre controls or in direct comparisons with viscous soluble fibre, where it is often used as a neutral comparator of soluble viscous fibre[121-124].

Mixed-fibre interventions emphasising high intakes of dietary fibre from a combination of types (insoluble, soluble and soluble viscous) and sources (cereals, fruit, vegetables and/or pulses), however, have shown cardiometabolic advantages. The WHO commissioned a series of systematic reviews and meta-analyses of RCTs inclusive of people without acute or chronic diseases (including individuals with pre-diabetes, mild to moderate hypercholesterolaemia, mild to moderate hypertension or metabolic syndrome), and earlier pooled analyses of randomised and non-randomised controlled trials in people with T2DM have evaluated mixed-fibre interventions. These have shown that mixed-fibre interventions result in improvements in HbA1c, post-prandial glycaemia, BP, blood lipids and reductions in body weight[125]. Dose thresholds for benefit are unclear but generally support optimal benefits at intakes of ≥ 25 g/ day of total fibre in mixed-fibre interventions providing 10 g/day to 20 g/day of soluble viscous fibre[111,126].

Low-calorie sweeteners

Syntheses of the evidence for low-calorie sweeteners and health outcomes have come to different conclusions. Important sources of disagreement appear to be the failure to account for the nature of the comparator in the interpretation of RCTs and the high risk of reverse causality in the models favoured by prospective cohort studies[127-129].

Systematic reviews and meta-analyses of RCTs and individual RCTs investigating the effect of low-calorie sweeteners in substitution for water, placebo or matched weight-loss diets (conditions under which there is no caloric displacement) have not shown improvements in cardiometabolic risk factors or weight loss[130,131], with few exceptions[132].

Systematic reviews and meta-analyses of RCTs and individual RCTs have also evaluated the effect of the intended substitution of low-calorie sweeteners for sugars or other caloric sweeteners (conditions under which there is caloric displacement, usually from sugar-sweetened beverages). This research has shown improvements in cardiometabolic risk factors (blood glucose, BP and liver fat) and modest weight loss in people with BMI ≥ 25 kg/m^2 [133-135]. Similar disagreements are seen depending on the models used in the prospective cohort studies.

Systematic reviews and meta-analyses of prospective cohort studies and individual large prospective cohort studies that have modelled baseline or prevalent intake of low-calorie sweeteners have shown an association with weight gain and an increased incidence of T2DM and cardiovascular diseases (CVDs)[129,130]. Other studies have used analytical approaches to mitigate reverse causality by modelling change in intake or substitution of low-calorie sweetened beverages for sugar-sweetened beverages. This research has reported associations with a decreased incidence of T2DM, CVD and all-cause mortality and weight loss[127,136,137] in populations inclusive of people with BMI ≥ 25 kg/m^2. Taken together, these different lines of evidence indicate that low-calorie sweeteners in substitution for sugars or other caloric sweeteners, especially in the form of sugar-sweetened beverages, may have advantages like those of water or other strategies intended to displace excess calories from added sugars. In an Irish context, dietary modelling using data from the National Irish Nutrition Survey has shown that intakes of the most commonly used sweeteners on the Irish market do not pose a concern as intakes were significantly below the relevant acceptable daily intake level[138].

Dietary patterns

Several interventions using specific dietary patterns have shown improvements in cardiometabolic risk factors, associated reductions in obesity-related complications and advantages for weight loss and maintenance (Table 1) The Mediterranean dietary pattern is a plant-based dietary pattern that emphasises a high intake of extra virgin olive oil, nuts, fruit and vegetables, whole grains and pulses; a moderate intake of wine, fish and dairy; and a low intake of red meats. This dietary pattern has shown improvements in glycaemia and blood lipids in addition to weight loss when compared with other dietary patterns in people with T2DM[6]. These improvements have been reflected in benefits in important clinical outcomes. The PREvención con DIeta MEDiterránea (PREDIMED) study was a large Spanish multi-centre randomised trial which was recently retracted and republished[7]. PREDIMED investigated a calorie-unrestricted Mediterranean dietary pattern, supplemented with either extra virgin olive oil or mixed nuts, compared with a control diet (calorie-unrestricted low-fat American Heart Association) in 7,447 participants at high cardiovascular risk. More than 90% of the participants had a BMI ≥ 25 kg/m^2. The researchers concluded that the Mediterranean dietary pattern reduced major cardiovascular events by ~30%, T2DM incidence by 53% (single-centre finding) and increased reversion of metabolic syndrome by ~30%, with little effect on body weight over a median follow-up of 4.8 year [7-10,139].

While a study from Northern Ireland found geographical and cultural barriers to implementing a Mediterranean diet in Northern European adults[140], counselling with a RD within a multi-disciplinary cardiac rehabilitation setting in the West of Ireland has been shown to result in a clinically significant improvement in Mediterranean diet score[141].

Numerous other dietary patterns have been investigated for their effects on cardiometabolic risk factors and obesity- related complications and body weight. These include:

- **Low-glycaemic index:** A dietary pattern that emphasises the exchange of low-glycaemic index foods (temperate fruit, dietary pulses, heavy mixed-grain breads, pasta, milk, yogurt, etc.) for high-glycaemic index foods[16-21,142-144].
- **Dietary approaches to stop hypertension (DASH):** A dietary pattern emphasising a high intake of fruit, low-fat dairy, vegetables, grains, nuts and dietary pulses, and a low intake of red meat, processed meat and sweets[22,23].
- **Portfolio:** A plant-based dietary pattern emphasising the in-take of a portfolio of cholesterol-lowering foods (e.g., nuts; plant-based protein from soy and pulses; viscous fibre from oats, barley and psyllium; and plant sterols, plus MUFAs from extra virgin olive oil or canola oil), all of which have EFSA-approved health claims for cholesterol lowering or CVD risk reduction[15].
- **Nordic:** A Nordic dietary translation of the Mediterranean, Portfolio, DASH and National Cholesterol Education Programme dietary patterns. Nordic emphasises foods typically consumed as part of a traditional diet in Nordic countries[25-29,145,146].
- **Vegetarian:** A plant-based dietary pattern that includes four main variants (lacto ovo vegetarian, lacto vegetarian, vegetarian and vegan)[12-14].

Systematic reviews and meta-analyses have shown that these different dietary patterns improved cardiometabolic risk factors in RCTs. They are associated with decreased incidence of T2DM and CVD in large prospective cohort studies inclusive of people with a BMI ≥ 25 kg/m^2.

Partial and total food replacement

Partial meal replacements are used to replace one to two meals per day as part of a calorie-restricted intervention. These calorie-restricted interventions have been shown to improve glycaemia, reduce BP, body weight and WC, compared with conventional, calorie-restricted weight-loss diets in a systematic review and meta-analysis of nine RCTs in people with a BMI ≥ 25 kg/m^2 and T2DM over a median follow-up of six months[30]. Another systematic review and meta-analysis of 23 RCTs reported programmes that include partial meal replacements achieved greater weight loss at one year compared with weight-loss programmes without use of partial meal replacements, with or without behavioural- change support[147]. These results are consistent with an earlier meta-analysis[148]. At one year, attrition rates were high, but better for the partial meal-replacement group compared with the calorie-restricted group (47% vs. 64%, respectively) with no adverse effects[148]. In 2021, an updated literature review was conducted by the McMaster Evidence Review and Synthesis Team in a collaboration between Obesity Canada (OC) and The European Association for the Study of Obesity (EASO). In relation to meal replacements, five additional papers with mixed levels of evidence (two Level 1a and three Level 2) were identified. This evidence was reviewed by the OC and Irish adaptation authors and concluded not to affect clinical practice, therefore no changes to the existing recommendations in either the OC or Irish MNT chapter will apply at this time. The updated references are listed here[30,147,149-151] in this chapter and also as an Appendix to the OC MNT chapter available at https://obesitycanada.ca/guidelines/nutrition.

Meal replacements have also shown advantages as key features of multi-component behavioural-intervention programmes targeting ≥ 5% – 15% of weight loss. The largest comprehensive behavioural intervention in people with type 2 diabetes, the Look AHEAD (Action for Health in Diabetes) trial, targeted ≥ 7% weight loss using meal replacements (with instruction to replace two meals per day with liquid meal replacements and one snack per day with a bar meal replacement) during weeks three to 19 of the behavioural intervention. Higher adherence to the use of meal replacements was associated with approximately four-times greater likelihood of achieving the ≥ 7% weight loss goal at one year, compared with participants with lower adherence at one year[152], contributing to better glycaemia and less health-related complications over the 9.6 years of follow-up[50,52]. The more recent Diabetes Remission Clinical Trial (DiRECT) included total diet replacement for the first 12 – 20 weeks of the intensive behavioural-intervention programme. DiRECT showed a nearly 20-fold greater likelihood of achieving diabetes remission at 12 months of follow-up in participants living with obesity and T2DM 49. Specific meal-replacement products are discussed in Chapter 16 Commercial Products and Programmes in Obesity Management.

In Ireland, a number of Level 3 obesity services incorporate milk-based total and partial meal-replacement programmes in MDT care pathways and show similar outcomes to that of the wider published literature. In Galway, an out-patient programme involving RD review every two weeks showed improvements in lipid profiles, HbA1c and reductions in anti-hypertensive and diabetes medication use along with mean weight loss of 15.9 ± 6.0% at 24 weeks in 105 individuals with complicated obesity[153]. Longer-term follow-up of weight outcomes in 78 of these individuals showed maintenance of 4.7 kg – 7kg at –three to four years[154]. Similarly, data from Dublin from 72 individuals with complicated obesity who completed a 12-week multi-component rehabilitation programme involving six weeks of inpatient care showed initial weight loss of between 14 ± 6.2 kg (7.9 ± 0.03%) and 16.2 ± 11.5 kg. Two-year follow-up data available on a small number of individuals (n = 11) who did not go on to have bariatric surgery, showed sustained weight loss of 8.2 kg ± 16 kg (5.5% ± 0.1%)[155,156].

VLCDs using meal replacements include MDT supervision and extensive support (including medical, nutrition, psychological and exercise counselling) as part of the intervention. Some practical aspects for RDs who are supporting people to use meal replacements as part of an MNT intervention include considering nutritional adequacy relative to requirements, managing possible side effects, understanding patients' lived experiences and awareness of current gaps in the evidence base[157]. Specific caution is advised in relation to this degree of energy restriction in older adults by the FSAI[85]. Long-term studies using VLCD interventions with partial meal replacements reported weight outcomes of -6.2% at year one and -2.3% at three years in those who attended over three years and did not have added pharmacotherapy treatment[158]. However, as weight loss or weight cycling can lead to biological compensatory mechanisms that promote long-term weight regain in some people[58-60], all other treatment options, including pharmacotherapy and bariatric surgery, should be considered in adjunct to support holistic obesity management.

Note: In Ireland, meal replacement products for use in calorie-restricted interventions are regulated by the FSAI[159].

Intermittent fasting

Intermittent fasting includes a variety of meal-timing approaches that alternate periods of extended fasting (no intake, or less than 25% of needs) and periods of unrestricted intake. Intermittent fasting is also described as time-restricted feeding, alternate-day fasting or intermittent energy restriction; however, there are multiple variations reported in the literature[160]. There was limited evidence in human physiology and metabolism studies. In a systematic review and meta-analysis of RCTs, Cioffi et al.[31] identified 11 trials (eight to 24 weeks) which found comparable outcomes between interventions using intermittent energy restriction compared with continuous energy restriction (glucose, HbA1c, triglycerides and HDL-C, weight, fat mass, fat free mass and WC). Intermittent energy restriction was identified to reduce fasting insulin levels (pooled difference -0.89 uU/mL) compared to controls; however, the study authors questioned the clinical significance of this as there were no differences in glucose, HbA1C or HOMA-IR. Adherence was similar between continuous and intermittent energy restriction groups, with higher attrition rates and adverse events in the intermittent energy restriction groups[31]. Similar results for weight loss and glycaemia followed in two papers

(one systematic review and meta-analysis and a systematic review) published in 2019 and 2020[160,161]. In the 2021 updated literature review referred to earlier, seven additional papers with mixed levels of evidence (two Level 2 and five Level 1a evidence) were identified in relation to intermittent fasting. This evidence was reviewed by the OC and Irish adaptation authors who concluded findings did not affect clinical practice, and therefore no changes to the existing recommendations in either the OC or Irish MNT chapter will apply at this time. The updated references are listed here[162-168] in this chapter and also as an Appendix to the OC MNT chapter available at https://obesitycanada.ca/guidelines/nutrition.

Food-based approaches

Several dietary patterns emphasising specific food-based approaches have shown advantages (Table 1). These include pulses (beans, peas, chickpeas and lentils)[32-36], fruit and vegetables[37,38,40], nuts[41-43,169-171] whole grains (especially from oats and barley)[39,44,111,118,172,173] and dairy[45,174-176]. These food-based approaches have shown improvements in cardiometabolic risk factors with weight loss and/or weight maintenance, in RCTs. There is also evidence of associated reductions in the incidence of T2DM and CVD in large prospective cohort studies inclusive of people with a BMI ≥ 25 kg/m^2.

Behavioural approaches

MNT interventions will more than likely involve some aspect of behaviour change on the part of the individual living with obesity (e.g., eating, managing medications), so behavioural-change supports should be incorporated into nutrition care plans. Common behaviour-change techniques used in MNT interventions are outlined in Appendix 3, Table 5 (adapted from the work of Michie *et al.*, 2011 & 2013; Craddock et al., 2017 and Samdal *et al.*, 2017[177-180]). Nutrition goals, therefore, may be structured to support changes to specific eating behaviours (e.g., speed of eating, eating in the absence of hunger), eating patterns (e.g., timing of meals and snacks, eating in front of screens), food planning (e.g., food shopping, meal planning) or specific nutrition targets linked to a behaviour (e.g., increasing intake of particular foods to increase protein intake). Behavioural-support strategies should involve setting and sequencing nutrition goals that are realistic and achievable, stimulus control, self-monitoring and analysing setbacks using problem-solving and adaptive thinking (cognitive reframing), including clarifying and reflecting on values-based nutrition behaviours. Documenting behavioural-change techniques used in MNT interventions can assist with monitoring and evaluation of practice[178].

Intensive lifestyle-intervention programmes

Intensive lifestyle-intervention (ILI) programmes consist of intensive multi-component behavioural interventions that are delivered by multi-disciplinary teams that may include physicians, RDs, psychologists, physiotherapists, occupational therapists and nurses. These programmes combine nutrition interventions with physical activity, behavioural support and, in some cases, also include obesity pharmacotherapy and use of partial and/or total meal replacement. In a synthesis of evidence, the intensity of follow-up varied from weekly to every three months, with gradually diminishing contact programme characteristic of programme designs[84]. ILI programmes that target ≥ 5% to 15% weight loss have shown marked improvements in cardiometabolic risk factors and obesity-related complications with sustained weight loss. Clinical benefits demonstrated in large, RCTs of ILI programmes[46,181-183] randomised programme include:

- Improved cardiovascular mortality and all-cause mortality in adults living with obesity who have impaired glucose tolerance[52];
- Improvements in glycaemia, BP and blood lipids in adults living with obesity who have impaired glucose tolerance pre-diabetes[176,181,182] or T2DM[46];
- A reduced incidence of T2DM[47,48,181-184];
- Improvements in microvascular complications in T2DM including retinopathy, nephropathy and neuropathy [48];
- Remission of T2DM in 35.6% of participants at 24 months[49]; and
- Reductions in the incidence of obstructive sleep apnoea[51] and depression[52] in adults with a BMI ≥ 25 kg/m^2 who have T2DM.

The available evidence suggests an overall benefit of different ILI programmes in adults living with obesity. However, the feasibility of implementing these programmes is dependent upon the availability of resources and access to a MDT and treatment options required to achieve the target weight-loss outcome (i.e., ≥ 5% to 15%) which may include pharmacotherapy, meal replacements and intensive behavioural support[185,186]. These types of programmes are described as sitting at Levels 2 to 4 of the Irish Model of Care with appropriate resourcing for multi-component treatment[66].

ILI programmes in Ireland have demonstrated effectiveness for several health-related outcomes. For example, an eight- to 10-week ILI programme (Croi-CLANN) resulted in significant improvements in self-reported mental health, QoL, cardiovascular risk factors including LDL-C, systolic BP and HBA1c and functional capacity, in addition to reductions in weight and WC[187,188]. In a community setting, a six- week dietetic-led ILI programme (Programme for Lifestyle, Activity & Nutrition or PLAN) reported improvements in QoL as well as reductions in BMI and WC[189]. A Level 3 programme that included individualised MNT, physiotherapy, psychology and pharmacotherapy showed improvements in pain with 37% (n = 177) of individuals losing ≥ 5% body weight while 59% (n = 279) remained weight stable (< 5% weight change)[190].

Non-restrictive dietary approaches

In the published literature, non-restrictive dietary approaches

include an umbrella of concepts that offer HCPs and people living with obesity alternatives to weight-loss-focused interventions that restrict food intake[191]. These approaches often reject weight loss or dieting practices and typically use concepts of increased awareness in relation to internal hunger, satiety, cravings, and appetite instead of caloric restriction or cognitive restraint. Components of a non-restrictive approach may include weight neutral/inclusive concepts, mindful eating, mindfulness-based interventions, size or body acceptance and/or Health at Every Size® (HAES®). Some dietary-pattern-based approaches that focus on food quality (e.g., Mediterranean diet) may also include non-restrictive elements to a greater or lesser degree depending on the intervention[192].

To date, evidence for non-restrictive approaches in obesity care is limited. A systematic review and meta-analysis of nine studies (involving 1,194 participants, BMI ≥ 25 kg/m^2 and follow-up over three to 12 months) compared weight-neutral approaches to weight loss interventions. Authors concluded that the two RCTs and seven non-randomised comparative studies found no significant differences in weight loss, BMI changes, cardiometabolic outcomes (including BP, glycaemia, lipid profile) or self-reported depression, self-esteem, QoL or diet quality. Small differences were found in self-reported bulimia and binge-eating behaviours[193]. Another systematic review of randomised and non-randomised trials found various non-restrictive approaches can positively influence eating behaviours (including disordered eating patterns), biochemical outcomes, fitness, diet quality, body image and mental health[53,194]. One systematic review specifically examined the Health at Every Size approach. HAES® does not support the medicalisation or pathological narrative that obesity is a disease. It's a philosophy centred on respecting body shape and size diversity, health-promoting eating and exercise behaviours based on non-weight-centric goals[195]. The review found this approach improved QoL and psychological outcomes (general wellbeing, body image perceptions) with mixed results for cardiovascular outcomes (blood lipids, BP), body weight, physical activity, cognitive restraint and eating behaviours[53]. Also, mindfulness-based interventions targeting self-awareness, specifically hunger, satiety and taste satisfaction, have been found to be effective for binge eating behaviours[196-198], eating disorders[196], positively affecting eating behaviours[191] and weight loss[199,200].

Caution is needed when interpreting results from non-restrictive approaches. Several non-restrictive interventions were conducted without control groups, met criteria for high risk of bias in trials and did not consistently apply valid tools to measure outcomes – more high-quality research is needed in this area[192].

Nonetheless, interventions focusing on non-weight-loss or weight-neutral outcomes may have less impact on weight stigma and may support health behaviours across all weight spectrums. "Best weight" (the weight at which the body stabilises when engaging in sustainable and enjoyable health behaviours) is a non-statistical goal first described by Obesity Canada[57]. The concept of best weight has the potential to synergise with health-focused and non-restrictive approaches during individualised MNT interventions in obesity management, as it recognises the complex relationship between health behaviours, health outcomes and body weight. MNT interventions that incorporate meal pattern stabilisation, flexible rather than restrictive eating styles and improving dietary quality to include more nutrient-dense foods may have parallels with interventions to manage and/or reduce the risk of disordered eating[201].

Clinical nutrition implications for acute weight loss

In complex cases, some individuals living with obesity may benefit from acute weight loss. In some cases, the possible benefits may include preservation of life, prevention of organ failure and/or for improving functional QoL (i.e., compromised activities of daily living). Despite the possible risks associated with weight loss (i.e., longer-term weight regain, increased appetite, loss of lean body mass, etc.), in specific cases, when weighed up against the possible benefits, acute weight loss via MNT may be a recommended treatment option. An important consideration in these cases is the risk of malnutrition and/or sarcopenic obesity in some individuals[202-205]. For example, weight reduction for people with knee osteoarthritis is often recommended to reduce pain and decrease the risk of infection for surgery (rates are higher in patients with BMI > 30 kg/m^2 after total knee replacement)[206]. However, BMI is not a good indicator of health or body composition, and weight reduction may not improve risk or outcomes due to loss of muscle due to inadequate nutritional intake, or adverse musculoskeletal outcomes in individuals with sarcopenic obesity[206,207]. Sarcopenic obesity is associated with accelerated functional decline, frailty, increased morbidity and mortality and should be screened for as part of the Edmonton obesity staging system (EOSS) assessment[208,209].

Even in the case of acute weight-loss interventions, nutrition interventions should focus on optimising nutritional, medical, cardiometabolic, mental and functional health. HCPs should use non-judgemental approaches when exploring the benefits and risks of any MNT intervention, including acute weight-loss interventions Likewise, family members and/or the public should not judge or scrutinise individualised interventions indicated or selected by the patient/client and their HCP. Conducting a comprehensive EOSS assessment (collaborating with a CORU RD and / or working with a specialist MDT) is recommended for the safe and effective use of nutrition interventions for acute weight loss.

Other considerations

Micronutrient deficiencies

People living with obesity are at increased risk for micronutrient deficiencies including but not limited to vitamin D, vitamin B12 and iron. The prevalence of vitamin D deficiency in Ireland is high with 40% of the adult population having serum vitamin D levels of < 50 nmol/L[210]. Consequently adults > 65 years in Ireland are advised to consider taking a daily supplement of 15 ug / 600 IU vitamin D[85,211]. Deficiency levels in obesity has been reported to be

as high as 90%[212], theorised by decreased bioavailability of vitamin D as it is sequestered in adipose tissue[213] or due to volumetric dilution[214]. Systematic reviews and meta-analyses of RCTs indicate that higher adiposity levels (percentage fat mass or fat mass) is associated with lower serum vitamin D 25(OH) D levels[215-217], suggesting the need for HCPs to monitor vitamin D levels as part of routine assessment for obesity. Vitamin D supplementation however has not been effective in treating obesity or for improving cardiometabolic outcomes as shown by meta-analyses of RCTs[216,218,219]. Vitamin D assessment and supplementation for correction and/or prevention of deficiency (< 50 nmol/L as defined by the Institute of Medicine[220]) is recommended in individuals at high risk for vitamin D deficiency (see Table 3), including individuals with metabolic bone disorders, older adults with a history of falls, clinically significant muscle weakness, malabsorptive conditions, liver/renal disease, chronic inflammatory conditions and use of certain medications[221]. This should be undertaken as part of a comprehensive EOSS assessment. Individuals with obesity may need a higher dose (two to three times higher; at least 6000 IU/d – 10,000 IU/d) of vitamin D to treat deficiency[222].

Restrictive eating patterns, obesity treatments (e.g., medications, bariatric surgery) and drug-nutrient interactions may also result in micronutrient deficiencies, specifically vitamin B12 and iron deficiencies[212,223,224]. There is also growing evidence for thiamine (vitamin B1) and magnesium deficiencies[225]. Vitamin B12 deficiency has been shown to be associated with higher BMI categories[226]; however, interpretation of observational studies is cautioned due to large heterogeneity within studies. Poor iron status has also been associated with obesity with a 1.31-fold increased risk for iron deficiency in people living with obesity[223]. Assessment including biochemical values can help inform recommendations for food intake, vitamin/mineral supplements and possible drug-nutrient interactions (Table 3) and there is further guidance on supplementation following bariatric surgery outlined in Chapter 14 Bariatric Surgery: Postoperative Management.

Disordered eating

A National Clinical Programme for Eating Disorders (NCP-ED) was established in Ireland in 2018. This is a collaboration between the HSE, the College of Psychiatrists of Ireland and BodyWhys (the Eating Disorders Association of Ireland). The overarching aim of this clinical programme is to improve the clinical outcomes and recovery of people with eating disorders in Ireland[227]. Based on epidemiological projections, an estimated 188,895 people in Ireland will experience an eating disorder at some point in their lives[228].

The fields of obesity and eating disorder research have historically worked in parallel, rarely crossing or meeting[229]. Weight stigma is an established risk factor for disordered eating[230]. Evidence shows mixed results, however, as limited studies have specifically assessed whether "dieting" practices (for pursuit of an ideal body weight or shape, drive for thinness and goals of weight loss) precipitate eating disorders (such as binge eating disorder or disordered eating behaviours). Epidemiological data over a 20-year longitudinal study indicated that eating disorders, drive for thinness, use of diet pills, laxatives and dieting methods to control weight declined in adult women but increased for adult men[231]. However, the underlying biological factors contributing to the manifestation of eating disorders remains poorly understood[232].

Multi-morbidity is considered a common feature of eating disorder progression[232]. In the context of obesity, binge eating disorder (BED) and night eating syndrome (NES) are particular eating disorders commonly observed among those living with obesity[233]. The presence of such eating disorders may impact the treatment of other facets of obesity treatment, such as the management of T2DM. This is further compounded by research which suggests that patients with BED have a higher prevalence of T2DM when compared to general population matched controls, 15.2% vs. 2.2%[233,234]. A systematic review exploring BED and NES in adults with T2DM concluded that healthcare professionals working in the field of T2DM should be vigilant regarding the possible diagnosis of BED or NES in their patients, but further research is required in the concurrent management of these eating disorders alongside T2DM treatment[16]. Data from a Level 3 service in Ireland found that 7.6% of patients met the diagnostic criteria suggestive of NES[235].

A systematic review by the Australian National Eating Disorder Collaboration concluded that professional obesity-management interventions (using MNT, physical activity, behaviour therapy, pharmacotherapy or surgical interventions) does not precipitate eating disorders or increase risk for eating disorders in people with BMI ≥ 25 kg/m^2 [236]. A recent paper also suggested that there may be differences between self-directed diets that promote ideal body size and restricted eating, and supervised evidence-based obesity treatments that focus on sustainability and health and eating disorder risks[201].

However, eating disorders are often underdiagnosed and untreated, and some evidence suggests that people with eating disorders are more likely to seek weight-loss interventions[237]. Compassion-focused therapy for eating disorders is a relatively novel approach which has been proposed for the treatment of eating disorders[238]. An Irish study showed that this approach has been shown to elicit beneficial results in relation to the reducing of self-criticism and shame in groups of people with eating disorders[238]. HCPs should consider referral to mental health professionals and/or eating disorder programmes for assessment and treatment if symptoms are suspected (see Chapter 7 the Role of Mental Health in Obesity Management).

Limitations and opportunities

To support evidence-based practice, guideline chapter authors examined the literature to find the highest-quality evidence to inform graded recommendations. High-quality evidence was identified for specific nutrition-related topics including MNT delivered by a RD, specific dietary patterns, certain food-based approaches and intensive behavioural interventions. There was

limited evidence for non-restrictive approaches. Gaps in the literature included assessment of baseline nutrition status and social determinants of health. Most studies with a nutrition component were short- to medium-term interventions, limiting our knowledge of long-term outcomes. Studies using BMI > 25 kg/m^2 as inclusion criteria to select participants for obesity interventions may be confounded with healthy people with larger bodies and misrepresent clinical outcomes for people with the chronic disease of obesity, and additionally may not identify those at nutrition risk.

Weight loss was a common outcome measure of intervention studies; however, the reason for weight change is difficult to ascertain. The success or failure of the intervention on weight outcomes is confounded by the physiological defence mechanisms in response to adiposity changes, as discussed in Chapter 3 the Science of Obesity.

To move nutrition and obesity practice forward, we suggest the following:

- Develop nutrition assessment tools across the spectrum of levels in the Irish Model of Care to support the use of a health-complication-centric definition of obesity, rather than relying on anthropometric measures for BMI categories.

- Improve accuracy of nutrition interventions for people with obesity with measurements of energy, macro/micronutrient needs, body composition (including obesity, sarcopenia) and health outcomes.

- Greater exploration of the relationships between food, food security, internalised weight bias, weight stigma and/or discrimination, eating behaviours and social determinants of health as part of patient care and research.

- Include the patient/client voice in nutrition research and patient care to help align the interventions for people living with obesity and people with larger bodies with their lived experiences.

- Future research should compare nutrition interventions using new definitions of obesity and assess nutrition-related outcomes, health-related outcomes and behaviour change instead of weight-loss outcomes alone across all weight spectrums.

- Evidence continues to emerge that impacts our understanding of nutrition and chronic disease. Providers may look to enhance their professional knowledge on emerging evidence in nutrition-related topics, including:
  - Neurophysiologic pathways that affect hunger, appetite and reward;
  - Metabolic adaptation of caloric restriction;
  - Gut microbiota;
  - Nutrigenomics and personalised nutrition;
  - Social determinants of health; and
  - Mental health.

Conclusion

MNT and coordination of care with a RD can help patients/clients improve health and QoL. Finding a nutrition approach a patient/client can incorporate into their lives that is nutritionally adequate, culturally acceptable, affordable, enjoyable and effective for lifelong health improvements (Figure 2) should be the focus of all nutrition interventions. Nutrition interventions show benefits with cardiometabolic outcomes, including glycaemia, hypertension, lipid profile and cardiovascular risk (Table 1 and Figure 1). There are multiple dietary patterns and approaches that have demonstrated clinically significant improvements in health and weight and/or adiposity outcomes. Caloric restriction may be effective in the first 12 months of treatment; however, it is difficult to sustain given the physiological hunger, appetite and satiety responses to restriction. There are instances where significant weight loss (> 5%) is recommended to address health outcomes (e.g., improve glycaemia in T2DM) and prepare for medical/surgical procedures (e.g., bariatric surgery). Micronutrient deficiencies are common among people living with obesity and post-surgery. Full nutritional assessment and diagnoses should be documented for patients using the NCP. Behaviour-change techniques are used alongside MNT to support patients/clients in implementing health behaviour change. Non-restrictive dietary approaches and supporting patients/clients in achieving a healthy nutrition status at their "best weight" may be appropriate. In collaboration with patients/clients, the evidence presented can be used as a guide to identify and plan the most appropriate personalised nutrition therapy approach.

Research in the field of obesity is continually evolving and the evidence base is growing. This, coupled with the implementation of the HSE Model of Care is a unique opportunity for the improvement of care for patients living with obesity in Ireland[66].

Figure 1: **Medical Nutrition Therapy for Obesity Management – Quick Reference Guide**[239,240]

ASK/ASSESS:
Is your patient/client interested in making nutrition changes?

NO → Monitor and evaluate for readiness in follow-up visits.

YES ↓

ADVISE: Provide/Reinforce Key Nutrition Messages for all Adults

- Meet individual values, preferences and goals that are culturally acceptable, affordable and sustainable
- Use person-first language, patient-centred, weight-inclusive and non-dieting approaches
- Consider the Irish healthy eating guidelines (as applicable to the individual

Healthy eating is more than the foods you eat.

- Be mindful of your eating habits
- Cook more often
- Enjoy your food
- Eat meals with others
- Use food labels
- Limit foods high in sodium, free sugars or saturated fat
- Be aware of food marketing and how it can influence your choices

Make it a habit to eat a variety of healthy foods each day.

- Have plenty of vegetables and fruit
- Eat protein foods and choose protein foods that come from plants more often
- Make water your drink of choice
- Choose whole grain foods

Build a healthy relationship with food and eating

- Take time to eat
- Notice when you are hungry and when you are full
- Plan what you eat
- Involve others in planning and preparing meals
- Culture and food traditions can be part of healthy eating
- Reconnect to the eating experience by creating awareness of your feelings, thoughts, emotions and behaviours

↓

ASK/ASSESS
Is patient/client interested in making further nutrition changes OR requests additional support to make/sustain changes?

NO → (Monitor and evaluate for readiness in follow-up visits.)

YES ↓

AGREE AND ASSIST: Explore Options, Collaborate Care

Refer to a CORU Registered Dietitian (RD)

Food Based Approaches

- Pulses
- Vegetables and fruit
- Nuts
- Whole grains
- Dairy foods

Dietary Patterns

- Calorie-restricted patterns with variable macronutrient ranges
- Mediterranean
- Vegetarian
- Portfolio
- Low glycaemic index
- DASH
- Nordic
- Partial meal replacements
- Intermittent fasting

Intensive behavioural interventions with a multi-disciplinary team

- Behaviour modification
- Nutrition (RD)
- Partial meal replacements
- Physical activity
- Education
- Self-monitoring/self-care
- Medications
- Frequent follow-up visits

↓

Monitor and Evaluate Health-Related Outcomes,* including:
Health behaviours, nutrition status, quality of life, mental health, cardiovascular, body composition, metabolic, functional status

↓

Reassess intervention, plan, readiness, barriers and supports.

*Refer to Table 2: Health Indicators for Evaluating Nutrition Interventions with Patients/Clients

Figure 2: **Summary of Clinical Outcomes for Nutrition Interventions**

	Hunger, satiety	Blood pressure	Blood lipids	Weight	Waist circumference	Body composition	CVD, CHD morbidity, mortality	Risk CVD	Glycaemia	Risk T2DM	Metabolic Syndrome	Quality of life	Depression
Medical Nutritional Therapy (RD)	■	■	■	■	■				■				
Intensive lifestyle interventions	NR	■	■	■			■		■		■		
Calorie restriction		■	■	■		■			■	■			
Lower carbohydrate				■									
Dietary fibre (25–29 mg)		■	■	■		■	■		■				
Low-calories sweeteners				■			■						
Higher protein (25–40%)	■		■	■		■							
Increased protein + calorie restriction			■	■		■							
Whey protein supplement		■	■	■		■			■				
Replace fat or carb with protein					■								
Lower fat				■									
Mediterranean			■				■		■	■	■		
Vegetarian			■	■			■		■	■			
Portfolio		■	■				■						
Low glycemic index			■	■			■			■			
DASH			■	■	■		■		■	■			
Meal replacements		■		■					■			■	
Intermittent fasting				■									
Pulses		■	■					■	■				
Vegetables and fruits		■					■		■	■			
Nuts			■				■		■				
Whole grains			■										
Dairy				■	■	■				■			
HAES®	■		■									■	■
Mindfullness-based approaches				■					■				

CHD: Coronary heart disease; CVD: Cardiovascular disease; HAES®: Healthy At Every Size®; T2DM: Type 2 Diabetes Mellitus

Table 1: **Summary of Nutrition Interventions Used in Obesity Management**

Intervention	Outcomes/Impact		Advantages	Disadvantages
	Health and quality of life	Weight change		
Medical nutrition therapy by a CORU registered dietitian (RD)	↓ 0.43% HgAlc ↓ 2.16 cm WC ↓ 4.06 mg/dL cholesterol ↓ 8.83 mg/dL triglycerides ↓ 4.43 mg/dL LDL-C ↓ 7.90 mmHg systolic blood pressure ↓ 2.60 mmHg DSP	↓ 1.03 kg[2] For T2DM: ↓ 1.54 kg[4] For T2DM prevention: ↓ 2.72 kg[3]	Use RDs as an adjunct or stand-alone therapy option for improvements in cardiometabolic and weight outcomes	Access to RDs trained in obesity management may be limited; fee for services from private practice providers
Intensive behavioural interventions	T2DM incidence 58%[47] ↓ 0.22 A1c, ↓ 1.9 mmHg systolic blood pressure, ↑ 1.2 mg/dL HDL-C[46] ↓ CDV (HR 0.67) and all-cause mortality (HR 0.74)[48] ↑ Remission of T2DM[49] ↓ Nephropathy incidence (HR 0.69)[50] ↓ Obstructive sleep apnea incidence[51] ↓ Depression (HR 0.85)[52]	↓ 8.6% 1 yr ↓ 6% 13.5 years[46]	Multi-modal approach with intensive counselling and strategies provides support to individuals for longer-term behaviour change and successful outcomes	Requires significant resources across multiple healthcare disciplines
Dietary pattern approaches				
Calorie restriction*	↓ Blood pressure, lipids, glucose[4,241,242] ↓ Bone density[80] ↓ Muscle strength[81] ↓ BMR[243]		Large initial weight loss[74,76,158,244]	Difficult to sustain, weight regain expected, long-term weight loss <5%.[76,158,244]
Lower carbohydrate		↓ 8 kg at 6 mo; ↓ 6–7 kg at 1 year[5]	Significant weight loss and improvement in glycaemia at 6 months	12-month glycaemia and weight outcomes comparable to other approaches, low fibre
Dietary fibre (25 g to 29 g)	Higher intakes: ↓ CVD mortality 15–30% ↓ Coronary heart disease, stroke incidence ↓ T2DM ↓ Systolic blood pressure ↓ Total cholesterol[111]	Higher intakes ↓ weight	Fibre supplements may help ↓ weight short-term[9,245-249]. Type and quantity of fibre intake also a consideration in bowel dysfunction	
Low-calorie sweeteners	May ↓ weight and cardiometabolic disease[131,250]		As a replacement for sugar (e.g. SSB) may help ↓ weight[133]	Randomized control trials do not support use for obesity management[131]
Higher protein (25%–40% of calories from protein), no calorie restriction prescribed	↓ TG (-0.60 mmol/L)[91] Carb-to-protein ratio of 1.5:1 ↓ Chol, LDL[251] No change (with or without exercise) for HDL, FBG, fasting insulin[251]	↓ 0.39 kg BW ↓ 0.44 kg FM[91]	Greater satiety[252] Women with MetSyn had ↓ weight, ↓ fat mass with HP vs. low-fat/high carb[251]	No differences in other lipids or lean mass, attrition rates 30–40%[91]
Increased protein (1.1 g/kg or 30% protein intake), with calorie restriction	Short-term (12 ± 9.3 weeks): ↓ TG[252]	30% protein intake: No difference in wt loss, ↑ lean mass[253] ↓ Weight[254] 1.1 g/kg protein intake: short-term (12 ± 9.3 weeks): ↓ Weight ↓ Fat mass Less ↓ fat-free mass[252]	Greater satiety[252]	Short term (12 ± 9.3 weeks)[252] Limited health data collected

Intervention	Outcomes/Impact		Advantages	Disadvantages
	Health and quality of life	Weight change		
Dietary pattern approaches				
Whey protein supplement (20–75 g/day, 2 weeks – 15 months)	↓ CVD risk factors (systolic blood pressure, DBP, HDL, TChol, glucose[102]	↓ Weight (mean diff -0.56 kg) ↓ Fat mass (mean diff -1.12 kg[102] ↓ Lean mass (mean diff -0.77 kg)	Benefits found with or without calorie restriction[102]	Lack of evidence to guide dose or length of time for use[102]
Increase protein to replace other macronutrients	Replace some carbohydrate ↓ Waist circumference over 5 years[255] Replace some fat No effect[255]	No effect on long-term weight outcomes[255]		
Lower fat		↓ 8 kg at 6 mo; ↓ 6–7 kg at 1 yr[5]		
Mediterranean	↓ HbA1C 0.45, ↓ TG 0.21 mmol/L, ↑ HDL-C 0.07 mmol/L[6] ↓ Cardiovascular events (HR 0.69–0.72)[7] ↓ T2DM risk 52%[8,9] ↑ Reversion of MetSyn[10]	Little effect on weight or WC[7]		
Vegetarian	↓ HbA1c 29%, ↓ LDL-C 0.12 mmol/L, ↓non-HDL-C 0.13 mmol/L[12] ↓ T2DM incidence (OR 0.726)[13] ↓ Coronary heart disease incidence (RR 0.72) ↓ Coronary heart disease mortality (RR 0.78)[15]	↓ 2.15 kg <6 mo[12]		Risk of vitamin/ mineral deficiencies (iron, calcium, zinc, vitamin B_{12}, vitamin D)
Portfolio	↓ LDL-C 17% ↓ Apo B 15% ↓ Non-HDL-C 14%, ↓ CRP 32%, ↓ systolic blood pressure 1%, ↓ 10-yr coronary heart disease risk 13%[19]	No change		Individuals may find it difficult to meet the recommended food component targets**
Low-glycemic index	↑ HDL-C[256] ↓ T2DM risk[23] ↓ Coronary heart disease[21]	↓ 2.5 kg 18 months[257]		
Dietary Approaches to Stop Hypertension (DASH)	↓ CRP 1.01[23] ↓ LDL-C 0.20 mmol/L ↓ A1C 0.53% ↓ T2DM risk RR 0.82 ↓ Cardiovascular disease risk RR 0.80 ↓ Coronary heart disease risk RR 0.79 ↓ Stroke risk RR 0.81[22]	↓ 1.42 kg, ↓ WC 1.05 cm in 24 weeks[24]		
Partial meal replacements*	↓ Blood glucose in DM[258] ↑ HRQOL[259] ↓ Systolic blood pressure 4.97 mmHg ↓ DBP 1.98 mmHg ↓ A1C 0.45% at 24 weeks[30]	↓ 2.37 kg ↓ WC 2.24 cm at 24 weeks[30]	Large initial wt loss	Wt regain 3 year weight loss < 5%[259]

Intervention	Outcomes/Impact		Advantages	Disadvantages
	Health and quality of life	Weight change		
Food-Based Approaches				
Pulses	↓ FBG 0.82[32] ↓ LDL-C 0.17 mmol/L[33] ↓ Systolic blood pressure 2.25 mmHg[34] ↓ Coronary heart disease risk RR 0.86[35]	↓ 0.34 kg at 6 weeks[36]		
Vegetables and fruit	↓ DBP 0.29 mmHg[37] ↓ HbA1c 5.7%[38] ↓ T2DM risk 42%[39] ↓ Cardiovascular mortality HR 0.95[40]			
Nuts	↓ HbA1c 0.07% ↓ FBG 0.15 mmol/L[41] ↓ LDL-C 7.4%[42] ↓ Coronary heart disease risk HR 0.74			
Whole grains	↓ Total cholesterol (TC) 0.12 mmol/L ↓ LDL-C 0.09 mmol/L[44]			
Dairy Foods (with calorie restriction)	↓ T2DM risk 42%[39]	↓ 0.64 kg BW ↓ 2.18 cm WC ↓ 0.56 kg FM ↑ 0.43 kg lean mass[45]		
Non-Dieting Approaches				
Health at Every Size (HAES®)	↓ LDL-C ↑ Body image perceptions ↑ Quality of life scores (depression) ↑ Eating behaviour scores ↓ Hunger ↑ Aerobic activity	No change in BMI or weight loss	↓ Weight bias	Evidence limited to women with BMI >25 or disordered eating patterns.
Mindful eating	↓ 3.1 mg/dl (↓ 0.2 mmol/L) in blood glucose[260] prevention of increasing FG over time	↓ 3.3% weight at post-treatment ↑ 3.5% weight in follow-up[199] ↓ 4.2–5.0 kg (4.3–5.1%) mean weight at 18 mo[260]	↓ Sweet food intake[261]	Lack of consistency for validated mindfulness tools
Intermittent fasting		↓ 0.61 kg at 24 weeks[31]		

Apo B: Apolipoprotein B; BMI: body mass index; BMR: basal metabolic rate; BW: body weight; Carb: Carbohydrate; Chol: Cholesterol; CRP: C-reactive Protein; CVD: Cardiovascular Disease; DBP: Diastolic Blood Pressure; FBG: Fasting blood glucose; FG: fasting glucose; HbA1c; Glycated Haemoglobin FM: fat mass; HDL-C; high density lipoprotein cholesterol; kg: kilogram; HRQOL: Lower Health-related Quality of Life; LDL-C: low-density lipoprotein C; MetSyn: Metabolic Syndrome; SSB: Sugar Sweetened Beverages; TG: Triglycerides; TC: total cholesterol; T2DM: type 2 diabetes mellitus; WC: waist circumference; Yr: Year

* These are typically combined with extensive behavioural modification support.

** The Portfolio dietary pattern = 1g to 3 g/day plant sterols (plant-sterol containing margarines, supplements), 15 g to 25 g/day viscous fibres (gel-forming fibres, such as from oats, barley, psyllium, legumes, eggplant, okra), 35–50 g/day plant-based protein (such as from soy and pulses) and 25 g to 50 g/day nuts (including tree nuts and peanuts).

Table 2: **Health Indicators for Evaluating Nutrition Interventions with Patients/Clients**

Health Improvement	Health indicator	Example
Cognitive improvements	Memory, concentration, attention, problem solving, sleep hygiene	Ask client/patient to rate each of these health outcomes using a 0–10 scale, where 0 is low/poor and 10 is high/great: Energy level Stress Sleep hygiene Mobility Strength Pain Bowel health Mood Relationship with food Hunger Cravings Overall health
Functional improvements	Strength, flexibility, mobility, coordination, physical activity capacity, endurance, pain	
Medical improvements	Cardiometabolic, endocrine, gastrointestinal, wound care, nutrient deficiencies, changes to medications	
Body composition improvements	Body fat, muscle mass, bone health, waist circumference	
Appetite-related improvements	Hunger, satiety, cravings, drive to eat, palatability of foods	
Mental health	Disordered eating behaviours, self-esteem, self-efficacy, emotional regulation, mood/anxiety, addiction	

HCPs are encouraged to use health- and quality-of-life-related goals for evaluating effectiveness of nutrition interventions. Asking clients/patients what health improvements they are hoping to achieve by following or changing their nutrition approach helps to redirect weight-centric outcomes. Examples: energy level, cognitive improvements, functional improvements, cardiometabolic improvements, mental health and quality of life (mobility, self-hygiene, etc.).

Table 3: **Micronutrients of Concern in Adults Living with Obesity**

Micronutrient	Screen for Deficiency Risks	Drug or Nutrient Interactions
Vitamin D	1. Elevated adiposity with metabolic bone disorders, older adults with a history of falls, clinically significant muscle weakness, liver/renal disease or chronic inflammatory conditions 2. Medical conditions associated with fat malabsorption: • Crohn's disease • Ulcerative colitis • Coeliac disease • Liver disease • Cystic fibrosis • Short-bowel syndrome 3. Previous bariatric surgery (RYGB, SG, BPD, DS) 4. Low intake of calcium-rich foods 5. Limited sun-light exposure (i.e., night-shift workers, wearing long-sleeved clothing, northern climate) 6. Darker skin pigmentation	• Corticosteroids • Orlistat • Cholestyramine • Phenobarbital • Phenytoin • Anti-oestrogens • Anti-retroviral • Anti-fungal (e.g., ketoconazole)
Vitamin B12	1. Elevated adiposity 2. Medical conditions: • IBD (Crohn's disease, ulcerative colitis) • Type 2 diabetes mellitus (long-term use of metformin) • GERD • Positive Helicobacter pylori • Pernicious anaemia • Alcoholism 3. Restrictive eating patterns: • Vegetarian eating patterns • VLCD/meal replacements • Lower carbohydrate intake 4. Previous bariatric surgery (LAGB, RYGB, SG, BPD, DS)	• Metformin • Proton-pump inhibitors
Iron	1. Elevated adiposity 2. Medical conditions: • Crohn's disease • Ulcerative colitis • Coeliac disease • Liver disease • Peptic ulcers • Chronic kidney disease 3. Restrictive eating patterns: • Vegetarian eating patterns • Low protein intake • VLCD/meal replacements 4. Frequent blood donors 5. Blood loss (menstruation, GI tract bleeding) 6. Previous bariatric surgery (LAGB, RYGB, SG, BPD, DS)	• Interactions with calcium, poly-phenols (coffee/tea) • Excessive zinc intake (lozenges) • NSAIDs • Proton-pump inhibitors • H2 blockers

BDP: Biliopancreatic Diversion; DS: Duodenal Stitch; GERD: Gastroesophageal Reflux Disease; GI: Gastrointestinal; IBD: Inflammatory Bowel Disease; LAGB: Laparoscopic Adjustable Gastric Banding; SG: Sleeve Gastrectomy; RYGB: Roux-en-Y Gastric Bypass; NSAID: Nonsteroidal Anti-inflammatory Drug; VLCD: Very Low-Calorie Diets

The Medical Nutrition Therapy in Obesity Management chapter is adapted from the Canadian Adult Obesity Clinical Practice Guidelines (the "Guidelines"), which Obesity Canada owns and from whom we have a license. ASOI adapted the Guidelines having regard for any relevant context affecting the Island of Ireland using the ADAPTE Tool.

ASOI acknowledges that Obesity Canada and the authors of the Guidelines have not reviewed Medical Nutrition Therapy in Obesity Management chapter and bear no responsibility for changes made to such Guidelines, or how the adapted Guidelines chapter is presented or disseminated. As Obesity Canada and the authors of the original Guidelines have not reviewed the Medical Nutrition Therapy in Obesity Management chapter, such parties, according to their policy, disclaim any association with such adapted Materials. The original Guidelines may be viewed in English at: www.obesitycanada.ca/guidelines.

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Appendix 1:

Definitions of Terms Used in the MNT chapter

Obesity: Historically, obesity has been defined using a BMI of ≥ 30 kg/m^2. Chapter 6 Clinical Assessment of People Living with Obesity reviews the limitations and biases associated with using this BMI definition. Although increased body fat can have important implications for health and wellbeing, the presence of increased body fat alone does not necessarily imply or reliably predict ill health. For this reason, evidence reviewed in this chapter that included participants with overweight or obesity using BMI categories (≥ 25 kg/m^2 or ≥ 30 kg/m^2, respectively) without any reported adiposity-related health and social wellbeing impairments are referred to as "people with a BMI ≥ 25 kg/m^2" (descriptive characteristics of size, not health). The ASOI Adult Obesity Clinical Practice Guideline adaptation defines obesity as "a complex chronic disease in which dysfunctional or excess body fat (adiposity) impairs health". We use this definition rather than weight or BMI by referring to "adults living with obesity" using people-first language[54] and in support of changing the narrative about obesity[56,262].

Obesity management: The term "obesity management" is used to describe health-related interventions and improvements beyond weight-loss outcomes alone. If weight loss occurred as a result of the intervention, this should not be the focus over the health and QoL improvements.

Medical nutrition therapy (MNT): MNT is an evidence-based approach used in the nutrition care process (NCP) of treating and/or managing disease, used across a range of clinical settings, which focuses on nutrition assessment, diagnostics, therapy and counselling. MNT is implemented and monitored by a registered dietitian and/or in collaboration with physicians and other MDT members. For these guidelines, MNT will be used as a standard language in nutritional therapeutic approaches for obesity interventions.

Nutrition interventions: This term is used instead of "diet" to refer to evidence-based, nutrition-related approaches for improving health and weight outcomes instead of exclusively weight loss-focused ideals that are often associated with the term "diet".

Appendix 2:

Table 4: **The Nutrition Care Process: Nutrition Assessment Structure Checklist for Obesity** (adapted from Lacey et al., 2002 and Lacey et al., 2003)[71,72]

See Chapter 6 on Clinical Assessment of People Living with Obesity for additional information

Notes in preparation for assessment:

- **Consent:** Obtain from patients/clients as per local policy
- **Document relevant past medical, psychiatric, social, and surgical histories (including bariatric surgery)**
- **Patient understanding:** explore patient understanding of obesity and expectations about body weight and obesity

Step	Assessment Details	
	New referral:	On review:
1. Medical tests & procedures	• Document date, medical diagnosis and reason for referral • Summarise investigations/observations/ tests – e.g. EOSS 4 M's Assessment including metabolic, mechanical, mental, milieu • Include relevant MDT assessments & recommendations	• Comment on relevant new information in clinical notes or document 'nil new of dietetic relevance' if appropriate
2. Biochemistry (Also Refer to Table 3)	• Nutritional deficiencies – e.g. Vitamin D, B12, folate, ferritin, Hb • Glycaemia: HbA1c, fasting glucose, oral glucose tolerance test, glucose monitoring at home • Lipids: total cholesterol, LDL-C, triglycerides, HDL-C	• Renal / liver function: Electrolytes, eGFR, liver function tests • Gout: Uric acid levels • Thyroid function tests
3. Medications	• Document all medications or recent changes to same • Medications for weight loss and obesity complications • Note prescribed vitamin & mineral supplements	• Note medications with potential to increase appetite and contribute to weight gain. • Note previous or current use of laxatives.
4. Nutrition focused physical findings	• Digestive system: oral health, dentition, swallow, nausea and/or vomiting, reflux, pain or discomfort, bowel movements • Appetite: hunger, satiety, cravings, drive to eat, food palatability • Signs of muscle wasting / sarcopenic obesity • Signs of oedema / ascites • Wound care or lower leg lymphoedema • Sleep pattern / hygiene	• General physical appearance / presentation and functional indicators: energy / fatigue, strength, flexibility, mobility/movement, coordination, physical activity capacity, endurance, pain, dyspnoea resting or on exertion, stress, evidence of wounds/ulcers and healing process • Hand grip strength if appropriate • Cognitive function: memory, concentration, attention, problem solving • Menstrual cycle
5. Anthropometric measurements & Nutritional Requirements	Anthropometric measurements: • Anthropometry: weight, height, BMI, waist circumference, weight history • Body composition: body fat, muscle mass, bone health Nutritional Requirements (use dry weight if evidence of oedema/ascites) • Energy: BMR x PAL = EER – 30% deficit if energy restriction indicated. Consider Mifflin-St. Jeor equation to estimate BMR • Protein: Minimum 1g/kg adjusted body weight/d. INDI Nutrition support guide: 1.2g/kg ABW, 1.5-2.5g/kg IBW or for BMI >30 kg/m^2 75% of ABW value (65% in BMI>50 kg/m^2) • Fluid: No obesity specific guideline. Calculate 35 ml/kg/d (18-60 years) or 30ml/kg/d (>60 years) (may be unrealistic - ensure meeting minimum requirements)	• Requirements for obesity complications at EOSS stages 1-4, and/or other health conditions e.g. modifying carbohydrate in T2DM/PCOS, protein/Na/K+/fluid in liver/ renal disease/hypertension, fibre/fat in IBS/ GORD, and protein in sarcopenia. • Consider vitamin/mineral/ nutrient recommendations such as Vitamin D, iron, folic acid for women during childbearing age (even if not trying to conceive): 5mg if BMI>30 kg/m^2

Step	Assessment Details	
	New referral:	On review:
6. Food & Nutrition-related History	• Diet history or 'typical day': include pattern, portions, sources of energy, carbohydrates, protein, fats, salt, sugar, fibre, micronutrients, types of beverages, caffeine sources & quantity, alcohol, non-prescribed vitamin, mineral or other nutrient-based supplements, including eating behaviour patterns: night-time eating, eating in front of screens/TV, fast eating, secretive eating. • Factors affecting food intake: food preferences, work & social routines, restrictive behaviours, food allergies (diagnosed), food intolerances, food aversions	• Factors affecting food access: financial constraints, shopping, cooking skills, food storage and cooking facilities • Current or history of eating disorder or disordered eating behaviours
7. Summary of Nutritional Issues (Nutrition Diagnosis)	I. **If implementing Nutritional Assessment only (steps 1-6):** Summarise results of the Nutrition Assessment data e.g. 41 year old woman presenting with EOSS stage 3 obesity, reporting an irregular meal pattern, evening hyperphagia, inadequate protein intake for sarcopenia requirements, and Vitamin D3 15 nmmol/L. II. **If implementing Nutrition Diagnosis:** Document the Nutrition Diagnosis as a PES statement (problem, aetiology, signs & symptoms), using standardised terminology. III. **Assign appropriate status to PES statement** depending on the stage of treatment / intervention: 'new', 'active', 'resolved', 'discontinued'. **Examples of PES Statements using 'intake', 'behavioural-environmental', 'clinical' diagnosis domains:** **'Intake' Nutrition Diagnosis:** 'Excess carbohydrate intake related to food and nutrition knowledge deficit concerning the appropriate amount and types of dietary carbohydrates as evidenced by self-reported limited understanding of the relationship between complex carbohydrates and glycaemia, and diet history detailing 14 portions of carbohydrates in a typical day, mainly rice and breads and recent increase in HbA1c (increase from 50mmol/mol to 54mmol/mol over 6 months).'	**'Behavioural-environmental' Nutrition Diagnosis:** 'Disordered eating pattern related to psychological causes that put emphasis on food, weight, or shape as evidenced by meeting OSFED DSM-5 criteria', a food and nutrition related history detailing irregular meal pattern including long gaps between meals 3-4 days per week followed by excessive high fat and sugar foods at night time, occasions of binge eating (without purging) approximately 3-4 times per month and two episodes of 5%-6% fluctuations in body weight in the last 4 months.' **'Clinical' Nutrition Diagnosis:** 'Obesity class lll related to decreased energy needs as evidenced by diet and weight history of repeated cycles of calorie restriction, weight loss, and weight regain over the last 10 years, EOSS Stage 3, obesity related complications including joint pain, limitations in movement associated with body weight and hypertension (140/130 mmHg), waist circumference of 120cm, BMI of 40kg/m^2.' **If no Nutrition Diagnosis is identified:** this should be stated as "No Nutrition Diagnosis at this time" and a reason provided.
8. Nutrition Care Plan	Depending on the focus(es) of the intervention, categories include Food and/or nutrient delivery, Nutrition education, Nutrition counselling, Coordination of nutrition care, and Planned follow-up. The overall nutrition care plan should also align with interventions from other MDT HCPs.	

Appendix 3:

Table 5: **Common Behaviour-Change Techniques used in Medical Nutrition Therapy with Brief Explanations for Each** (adapted from Michie et al., 2011 & 2013; Craddock et al., 2017 and Samdal et al., 2017)[177-180]

Behaviour-Change Technique	Explanation/Example
Instruction on how to perform a behaviour	Providing individual with specific instructions on how to carry out a planned behaviour – e.g., informing individual verbally and/or with written resources how to modify the protein content of their meal(s).
Action planning	Detailed planning with individual of when and how they will implement change or plan related to situational factors – e.g., days per week and food preparation, choices and meals affected by agreed dietary changes.
Credible sources	Present verbal and/or visual information from a credible source in favour of or against a given behaviour – e.g., share video of a professor explaining the benefits of establishing regular meal pattern versus harms of diet/overeating cycles.
Goal setting (behaviour)	Encourage a behavioural resolution to make or maintain a change – e.g., individual agrees to include or reduce portions of specific foods daily.
Goal setting (outcome)	A general goal that can be achieved by behavioural means but is not defined in terms of behaviour – e.g., outcome goal to reduce blood pressure to be influenced by behavioural goals of DASH.
Plan social support	Prompting individual to identify and plan social support from other people that will help them in the achievement of target behaviours / outcomes – e.g., how immediate family could help with meal planning, shopping or cooking.
Self-monitoring of behaviour	Individual is asked to keep a record of specified behaviour(s) as a method for changing behaviour – e.g., keeping a food diary.
Feedback on behaviour	Providing feedback on recorded behaviour – e.g., reviewing food diary together or commenting on behavioural performance or identifying discrepancy between described behaviour and behavioural goal(s) and/or action plan.
Demonstration of the behaviour	Showing or providing a visual demonstration on how to perform a behaviour either in person or remotely – e.g., visual aide to demonstrate portion sizes either in person or using visual/audio-visual resource.
Set graded tasks	Breaking down the target behavioural goal into smaller, achievable tasks – e.g., plan meals, write shopping list, collate recipes, in preparation for implementing meals with more vegetable/salad portions.
Adding objects to the environment	Prompting individual to alter their environment(s) so that it is more supportive of the target behaviour – e.g., buying high-fibre snacks and leaving a range at work office to be available when hungry.
Problem solving	The individual is prompted to think about possible barriers to planned behaviour-change goals and consider how they would overcome barriers identified – e.g., aiming for ½ plate vegetables at dinner as a dietary behaviour change goal with lack of time to prepare/cook identified as a barrier, and weekend menu planning and quick options identified to help overcome the barrier.
Feedback on outcomes of behaviour	Monitor and provide feedback on the outcome of performance of a behaviour – e.g., information on latest blood pressure monitoring and assess progress following the implementation of dietary approaches to lower blood pressure.

Behaviour-Change Technique	Explanation/Example
Behavioural practice/ rehearsal	Individual is prompted to try the behaviour (or parts of it) by rehearsing and repeating the behaviour or preparatory behaviours several times – e.g., practicing reducing food intake at social occasions by eating a small meal in advance and individual is tasked with preparatory practice between sessions.
Avoidance/reducing exposure to cues for the behaviour	Advice on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines – e.g., social get-togethers and parties are identified barriers to diet behaviour change and individual adapts routine to reduce exposure for given period of time.
Review behaviour or outcome goals	Involves a review of previously set behavioural and/or outcome goals to assess what was achieved, followed by a revision or adjustment of goals as required – e.g., review behaviour goal to achieve ½ plate vegetables at main meal daily with aide of food diary (closely linked to self-monitoring of behaviour), discussing days achieved, obstacles encountered and restructuring or maintaining planned goal (likely linked to problem solving).
Self-monitoring of outcomes of behaviour	Asking an individual to keep a record of specified measures that are expected to be influenced by behaviour change – e.g., record of blood pressure measures at various time-points.
Self-monitoring of behaviour	Individual is asked to record specified behaviour(s) as a method for changing target behaviour(s) – e.g., diary recording portions of fruits and vegetables daily as a means to achieving target fruit & vegetable intake.
Pros and cons of behaviour change	Advise individual to identify and compare the reasons for wanting to (pros) and not wanting to (cons) change the behaviour – e.g., draw up list of the good things and a list of the drawbacks of including breakfast daily for the individual and use as tool to make decisions on behaviour-change priorities.