Guidelines for medical nutrition treatment of overweight/obesity in China (2021)

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Running title: Guidelines for MNT of overweight/obesity in China

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ABSTRACT

Obesity has become a global "epidemic". At this stage, overweight / obesity has become a major public health problem that seriously affects not only adults but also children and adolescents worldwide. Medical nutritional therapy is the basic treatment for obesity and an indispensable measure for prevention and control at any stage in the course of obesity. Management of co-morbidities and improving the quality of life of obese patients are also included in treatment aims. In recent years, there have been some guidelines on the nutrition management of overweight/obesity. However, the management of nutrition and lifestyle interventions must be compatible with specific regional dietary habits and social culture. To provide a clinical reference for the standardized treatment and management of overweight / obesity, guidelines for medical nutrition treatment of overweight/obesity in China (2021) were published, which cover the relationship of weight loss with different dietary patterns, meal replacement foods, biorhythms, intestinal microecology, metabolic surgery, and medical nutritional intervention, as well as weight loss in special populations. We hope the guidelines will improve the awareness of the importance of nutrition intervention in the treatment of metabolic disease, further regulate the principle and approach of medical nutrition therapy, and establish a workflow of standardized medical nutrition therapy for weight loss management so that more clinical nutrition professionals and medical staff can use it to provide better services for obese people.

Key Words: medical nutrition therapy (MNT), multidisciplinary, overweight, obesity, obesity management

INTRODUCTION

Obesity is a chronic metabolic disease caused by a combination of genetic and environmental factors that result in excess total body fat, increased localized fat content, or abnormal fat distribution. Obesity has become a global "epidemic," and the average BMI of the global population has been on the rise. In 2016, more than 1.9 billion adults over the age of 18 years were overweight globally, and 650 million were obese.[1] Similarly, the overweight and obesity rates in China offer no reason for optimism. The *Report on Chinese Residents' Chronic Diseases and Nutrition (2020)* showed that the overweight and obesity rates of all age groups continued to rise in both urban and rural areas, with more than half of adults being overweight or obese, and that the overweight and obesity rates among adolescents and children aged 6-17 years and <6 years reached 19.0% and 10.4%, respectively.[2] Obesity is a potential risk factor for diabetes mellitus, cardiovascular diseases, and other metabolic diseases, as well as tumors, and the high medical costs accompanying it place a heavy burden on the national economy, making obesity a major public health issue affecting physical and mental health. Medical nutrition therapy (MNT) is the basic treatment for obesity and plays an essential role in the prevention and control of obesity at any stage of its natural course.

With the accumulation of clinical research data and the update of evidence-based guidelines/consensus methodologies, nearly 100 Chinese scholars in the fields of evidence-based medicine, public health, nutrition, and metabolism research, as well as multidisciplinary experts in surgery and endocrinology, collaborated in 2021 to develop the *Chinese Medical Nutrition Therapy Guidelines for the medical nutrition treatment of overweight/obesity (2021)* (hereafter referred to as the *Guidelines*) based on the latest clinical evidence.

METHODOLOGY FOR THE DEVELOPMENT OF THE *GUIDELINES*

A literature support group was established, and a search of the literature published in the last 20 years was conducted to identify primary and secondary databases. The strength of recommendations was categorized using the criteria of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework (Tables 1 and 2). In each chapter, descriptions and assessments were made using the basic framework "background–clinical problem–recommendations–evidence briefing," in which lines of evidence were retrieved, summarized, and analyzed according to the clinical problem to formulate the recommendations. Evidence on key clinical issues was then summarized, and conclusions were drawn after full consideration of health economic aspects. Should a disagreement arise for certain recommendations, the Delphi method was adopted to reach an "evidence-based consensus" through discussions between the writing support group and the experts in each specialty, and the level of consensus was described in terms of the proportion of agreement.

METHODS OF MEDICAL NUTRITION THERAPY FOR WEIGHT LOSS

Calorie-restricted diet

Calorie-restricted diet (CRD) refers to the dietary regimen that reduces the daily energy intake by 500-1,000 kcal or by 1/3 of the recommended total calorie intake based on the target calorie intake, with carbohydrates accounting for 55-60% of total daily energy and fats accounting for 25-30% of total daily energy.[3,4] A growing number of studies have shown CRD to be an effective approach for weight management that can be used to reduce body weight and body fat content, thereby reducing the inflammatory response, lowering metabolic syndrome components, reducing risk factors for cardiovascular diseases,[5-9] improving sleep quality,[10] and alleviating anxiety symptoms.[11]

Question 1: What is the impact of protein sources and increased dairy intake on the effect of CRD interventions?

CRDs with increased proportions of soy protein intake may reduce body fat percentage, total cholesterol (TC), and low-density lipoprotein-cholesterol (LDL-c) levels (Level of evidence C, weak recommendation; 94.9% agreement). Increased dairy intake in CRD may reduce weight and body fat levels in overweight/obese individuals, whereas increased calcium supplementation alone does not enhance weight loss (Level of evidence B, weak recommendation; 92.4% agreement).

Liao et al[12] demonstrated in a small-sample study of 30 participants that compared to conventional CRDs, soy protein-based CRDs considerably reduced serum TC and LDL-c concentrations, as well as body fat levels, in overweight adults. Jones et al[13] examined whether supplementation with dairy products and a high-calcium dietary pattern can enhance weight loss and improve appetite regulation during a CRD intervention among overweight/obese adults. The results showed that increased calcium intake during the CRD intervention did not further enhance weight loss. Other dairy studies have also shown that increased dairy intake in combination with CRD interventions further reduced body weight and fat content.[14] The increase in low-fat milk intake, in particular, significantly reduced centripetal obesity.[15]

High-protein diet

A high-protein diet (HPD) is defined by both relative quantity (protein-to-energy ratio) and absolute quantity (protein intake), which mostly refers to a dietary pattern in which the daily protein intake exceeds 20% of total daily calorie intake or 1.5 g/kg/d, whereas the daily protein intake generally does not exceed 30% of the total daily energy intake or 2.0 g/kg/d. Several studies have confirmed that HPD reduces hunger, increases satiety and resting energy expenditure, reduces body weight, and improves various risk factors for cardiovascular diseases including glucose homeostasis and lipid concentrations.

Question 2: Can HPD improve weight and blood glucose in overweight/obese patients with type 2 diabetes mellitus (T2DM)?

HPD helps overweight/obese patients with T2DM to lose weight and facilitates glycemic control. Clinical monitoring, including renal functions, and nutritional counseling should be enhanced during long-term application of HPD (Level of evidence B, weak recommendation; 91.6% agreement).

In the open-label, cluster-randomized Diabetes Remission Clinical Trial (DiRECT), participants of the overweight/obese T2DM group were put within five years of diagnosis on calorie-restricted HPD and discontinued hypoglycemic agents and antihypertensives for three to five months before resuming CRD (with 15% protein energy supply ratio). At 12 months of follow-up, 24% of patients in the intervention group had lost more than 15 kg of weight, while the control group had lost 1 kg on average, with a statistically significant difference between the two groups. Meanwhile, T2DM was in remission in 46% of the patients in the intervention group, with a greater weight loss associated with a higher rate of T2DM remission.[16] No adverse effects on renal function were observed in any of the studies.

Question 3: What is the impact of HPD on adherence to weight loss interventions and the maintenance of weight loss outcomes?

HPD may increase satiety, reduce hunger, and help to enhance weight loss intervention adherence and maintain weight loss in severely obese individuals (Level of evidence C, weak recommendation; 93.3% agreement).

A meta-analysis by Johnston et al[17] compared the effects of multiple dietary patterns on weight loss among overweight/obese adults and found little difference in weight loss between dietary patterns. However, both satiety and adherence were better in the HPD group. HPD promotes the secretion of several gastrointestinal hormones, including glucagon-like peptide-1 (GLP-1), cholecystokinin, and peptide YY (PYY), as well as the transmission of neural stimuli to the central nervous system to form “satiety” signals, posing significant and long-lasting inhibitory effects on hunger perception.[18,19]

Question 4: Does HPD-induced weight loss cause bone loss?

HPD with a dairy-based high-quality protein source is helpful for maintaining bone mass (Level of evidence B, weak recommendation; 92.0% agreement).

A systematic review incorporating 16 randomized controlled trials (RCTs) and 20 prospective cohort studies showed no adverse effects of increased protein intake on bones.[20] A study by Josse et al[21] showed increases in osteocalcin, procollagen 1 amino-terminal propeptide (P1NP), P1NP to C-terminal telopeptide of type I collagen (CTX) ratio, and osteoprotegerin (OPG) to receptor activator of nuclear factor-κB ligand (RANKL) ratio among participants in the dairy-based HPD group with no changes in bone resorption markers, suggesting that increasing dairy-derived protein had a positive effect on maintaining bone mass.

Question 5: What is the effect of HPD supplements with different protein sources on weight loss?

HPD supplements with casein hydrolysate, lactalbumin hydrolysate, or soy protein as protein sources may all contribute to weight loss (Level of evidence B, weak recommendation; 95.4% agreement).

Denysschen et al[22] assessed HPD supplemented with soy or whey protein combined with resistance training in overweight men with hyperlipidemia to evaluate HPD-induced effects on strength gain, body composition, and blood lipids. The results showed that body fat content, waist-to-hip ratio, and TC concentrations were significantly lower in all study groups. However, none of the intergroup differences were statistically significant. A systematic review including nine RCTs showed that whey protein supplementation improved body weight, total body fat percentage, and certain risk factors for cardiovascular diseases in overweight/obese individuals.[23]

Low-carbohydrate diets

Low-carbohydrate diets (LCDs) usually refer to diets with a carbohydrate-to-energy ratio of ≤ 40%, a fat-to-energy ratio of ≥30%, and a relatively high protein intake, with or without restrictions on the total calorie intake.[24,25] Very-low-carbohydrate diets (VLCDs) aim for a dietary carbohydrate-to-energy ratio of ≤20%. Ketogenic diets are an extreme type of VLCD. In recent years, an increasing number of RCTs and meta-analyses have reported significant weight loss caused by short-term application of LCDs. However, the adverse consequences of long-term LCDs and whether they cause micronutrient deficiencies have seldomly been evaluated.

Question 6: Are LCDs beneficial for weight loss? Are they suitable for long-term use?

Short-term LCD interventions are beneficial for weight control and metabolic improvement (Level of evidence A, strong recommendation; 94.5% agreement). However, the long-term use of LCDs is not recommended (Level of evidence C, weak recommendation; 92.0% agreement).

The study by Sun et al[26] performed a four-week intervention with calorie-unrestricted LCDs combined with exercise in 58 overweight Chinese women and found significant weight loss, as well as a significant reduction in waist and hip circumferences, among the study participants. Liu et al[27] randomized 50 overweight/obese women into a calorie-unrestricted LCD group and a calorie-restricted group. The difference in weight loss between the two groups was not statistically significant after 12 weeks. However, the reductions in TC-to-high density lipoprotein-cholesterol (HDL-c) and TG-to-HDL-c ratios were greater in the LCD group. Moreover, both diets were equally effective in reducing body weight and body fat content. A two-year RCT compared the effects of calorie-unrestricted LCDs versus a healthy control diet on weight loss among postmenopausal obese women. The results showed that participants in the LCD group had more significant reductions in body weight and body fat content.[28] However, the safety and efficacy in the longer term require further investigation.

Question 7: Can LCDs be used to improve glycemic control in overweight/obese patients with T2DM?

The short-to-medium-term use of LCDs in overweight/obese patients with T2DM helps to improve glycemic control (Level of evidence A, strong recommendation; 93.7% agreement).

Tay et al[29] randomized 115 overweight/obese participants with T2DM to a calorie-restricted LCD group and a normal carbohydrate group. After a 52-week intervention, decreases in body weight, HbA1c, and fasting glucose concentrations were observed in both groups, with greater improvements in glycemic stability and less need for hypoglycemic agents in the calorie-restricted LCD group. A meta-analysis combining 33 RCTs and three controlled clinical trials included 2,161 participants and found better improvement in HbA1c among T2DM patients on short-term LCDs compared to those on a low-fat diet.[25]

Question 8: Are LCDs suitable for weight loss in children and adolescents who are overweight/obese?

Long-term LCDs for weight loss purposes in children and adolescents are not recommended. Short-term LCDs may be performed under the strict guidance of a clinical dietitian, and serum micronutrient levels should be tested regularly with appropriate dietary fiber and micronutrient supplementation (Level of evidence C, weak recommendation; 92.0% agreement). Goss et al[30] conducted an eight-week intervention with LCDs in 32 children and adolescents aged 9-17 years who had obesity and metabolic associated fatty liver disease (MAFLD). The results showed significant decreases in the insulin resistance index, visceral fat level, and body fat content compared to pre-intervention levels. Due to the limited food choices of LCDs, the intake of fruits and vegetables was much lower than that of meat and fat, and the intake of dietary fiber, calcium, iodine, magnesium, zinc, and iron may be lower than the recommended intake levels.[31]

Question 9: Can ketogenic diets be used for medical weight loss?

With due regard to safety and after failed interventions using other dietary patterns for weight loss purposes, management with a short-term ketogenic diet may be performed under the guidance of a clinical dietitian. In addition to monitoring serum ketones, changes in liver and kidney functions, as well as body composition, should be monitored, with close attention to serum lipid concentrations (Level of evidence B, strong recommendation; 92.4% agreement).

Short-term ketogenic diets may be applied continuously or intermittently for weight management with multidisciplinary interventions such as lifestyle changes and psychological counseling. However, the safety of long-term ketogenic diets has not been demonstrated.[32] An open-label, multicenter, prospective study included 89 obese T2DM patients with a BMI between 30 and 35 kg/m^2, who were grouped to receive a ketogenic diet or conventional LCD interventions. The results of the four-month interventions showed significant decreases in weight and HbA1c concentrations, as well as a significant reduction in waist circumference, in the ketogenic diet group.[33] A meta-analysis that included 13 RCTs compared the effects of ketogenic diets and low-fat diets on body weight at 12 months of intervention. The results showed that those who received the ketogenic diet intervention had more significant weight loss, as well as significantly lower blood pressure values and TG concentrations, but significantly higher LDL-c and HDL-c concentrations.[34]

Intermittent energy restriction

Intermittent energy restriction (IER) is a dietary pattern of fasting or having limited energy intake within a specified period in a regular pattern. Several studies have found IER to be effective not only for weight loss but also for metabolic diseases. Currently, the commonly used IER methods include alternate-day fasting (fasting every 24 h), 4:3 or 5:2 IER (fasting two to three days per week on consecutive/nonconsecutive days), etc. During the fasting period of the IER, the energy supply is usually 0-25% of the normal requirement.[35] A study has shown that participants in the IER group had significantly lower body weight, BMI, lean body mass, and body fat content, as well as significantly smaller waist circumference, compared to the conventional diet group.[36] However, the advantageous effects of IER were not significantly different compared to those of continuous energy restriction (CER).[37,38] Moreover, there was no significant difference in weight loss between different types of IER methods.

Question 10: What are the effects of IER interventions on weight loss, lipid metabolism, and carbohydrate metabolism in overweight/obese individuals?

Compared to conventional diets, IER interventions may reduce body weight and improve lipid metabolic markers in overweight/obese individuals (Level of evidence A, strong recommendation; 96.6% agreement). In nondiabetic overweight/obese individuals, IER may improve insulin resistance and increase insulin sensitivity. However, the effects on blood glucose concentrations remain uncertain (Level of evidence B, strong recommendation; 97.5% agreement).

A systematic review and meta-analysis by Schwingshackl et al[37] included 17 RCTs with a total of 1,328 participants observed for ≥ 12 weeks. The results showed that participants in the IER group had more significant decreases in body weight, adipose tissue content, and TG concentrations compared to those in the conventional diet group and that both diets had similar effects on improvements in LDL-c and TG concentrations. A systematic review by Meng et al[39] found that compared to no diet, IER significantly reduced TC, LDL-c, and TG concentrations with favorable effects on lipid metabolism.

The systematic review by Cho et al[40] evaluating IER effects on BMI reduction and glucose metabolism in nondiabetic study populations showed that participants in the IER group had both improved fasting glucose concentrations and insulin resistance compared to baseline values. The systematic review by Barnosky et al[41] compared the effects of IER and CER in overweight/obese adults, and the results showed that both fasting insulin and insulin resistance levels were decreased in participants of the IER group, although comparable to those in the CER group, with no consistent results regarding the effects on glycemia.

Question 11: How are the safety of and adherence to IER?

Compared to conventional diets, IER is safe for weight loss in healthy individuals. Compared to CER, IER is also relatively safe for diabetic patients, but adjustment of hypoglycemic agents may be required (Level of evidence C, weak recommendation; 93.7% agreement). To improve adherence, the management of populations receiving IER interventions should be strengthened (Level of evidence C, strong recommendation; 95.4% agreement).

Kessler et al[42] assessed IER in healthy volunteers, and the results showed no serious adverse events in the IER group compared with the healthy diet group, while 76% of adverse events were related or possibly related to fasting, including headache, nausea, irritability, circulatory disorders, weakness, fatigue, stomach pain, and heartburn. The systematic review by Rajpal et al[43] examined the efficacy and safety of IER plans for patients with metabolic syndrome, prediabetes, or T2DM. The results showed that IER was generally effective and relatively safe but increased the risk of hypoglycemia, particularly in T2DM patients treated with insulin or sulfonylureas, and that adverse effects associated with the use of such drugs may limit the efficacy of these regimens. Corley et al[44] compared the hypoglycemia risks of IER interventions in patients with diabetes. The results showed that the mean hypoglycemia incidence over 12 weeks was 1.4 events and that although fasting days increased the risk of hypoglycemia, the overall incidence remained low and may be improved with medication adjustment.

Low glycemic diet

Food with a low glycemic index (GI) is characterized by low energy supply and high dietary fiber content, which can relax the receptivity of the gastrointestinal tract and increase satiety, thereby contributing to lower total energy intake. A systematic review that included six RCTs showed that participants on a low-GI diet had more significant reductions in body weight, BMI, and total fat content than those on a high-GI or low-fat diet.45 Another systematic review that included 101 studies with a total of 8,527 participants showed that low-GI diets had favorable effects on weight loss.[45,46] A systematic review that included 14 RCTs confirmed that low-GI diets also improved insulin resistance.[47]

Question 12: Are low-GI diets helpful for losing weight?

A low-GI diet with total energy restriction may reduce weight in obese individuals, and the short-term application of a low-GI diet is better than that of a high-GI diet for losing weight (Level of evidence B, weak recommendation; 96.6% agreement). The short-term application of a low-GI diet may increase satiety and improve insulin resistance (Level of evidence C, weak recommendation; 95.8% agreement).

A systematic review included six RCTs with continuous interventions for five weeks to six months with a six-month follow-up. The results showed that participants on a low-GI diet had significantly lower body weight, total fat content, and BMI compared to those on a high-GI or low-fat diet.[45] Abete et al[48] investigated the effects of two CRDs with different food allocations and GI values on weight loss and energy metabolism. The three macronutrients accounted for the same proportions of total energy in the two experimental diets, but more dietary fiber was provided in the low-GI group. After eight weeks of intervention, participants in the low-GI group lost significantly more weight than those in the high-GI group. However, the waist circumference, body fat content, lean body mass, and resting energy expenditure were similar in both groups.

A systematic review that included 32 RCTs found that short-term low-GI diets had a stronger satiating effect than short-term high-GI diets and that the mechanism may be the specific effect of blood glucose concentrations on satiety (glucose suppression) and other factors involved in appetite control.[49]

Multiple dietary patterns

Dietary approaches to stop hypertension

Dietary approaches to stop hypertension (DASHs) emphasize increases in the intake of vegetables, fruits, low-fat (or skim) milk, and whole grains, as well as reductions in the intake of red meat, fats, refined sugars, and sugar-sweetened beverages, with an appropriate intake of nuts and legumes to provide electrolytes such as potassium, magnesium, and calcium, as well as dietary fiber. Thus, DASHs emphasize increases in the intake of high-quality protein and unsaturated fatty acids, as well as reductions in fat, especially saturated fatty acids and cholesterol.[50]

Question 13: Do DASHs help overweight/obese individuals to lose weight compared to conventional diets?

DASH is effective in reducing weight, BMI, and body fat content in overweight/obese individuals compared to conventional diets (Level of evidence B, strong recommendation; 96.2% agreement).

The RCT by Kucharska et al[51] investigated 126 overweight/obese patients with primary hypertension, and the results showed significant reductions in body weight, blood pressure, body fat content, fasting glucose, insulin, and leptin levels in the three-month DASH group compared to the control group without nutritional intervention. Shenoy et al[52] conducted a 12-week RCT on 81 patients with metabolic syndrome, and the results showed that DASH significantly reduced body weight compared to the control diet.

Mediterranean diet

The structure of the Mediterranean diet is characterized by plant-based foods, including whole grains, legumes, vegetables, fruits, and nuts, with moderate quantities of fish, poultry, eggs, and dairy products, and small amounts of red meat and its products. The main edible oil is olive oil, and red wine is consumed in moderate amounts. The nutritional characteristics include a fat energy supply ratio of 25-35%, with a low intake of saturated fatty acids (7-8%) and a high intake of unsaturated fatty acids.

Question 14: Does a Mediterranean diet help overweight/obese individuals to lose weight compared to a conventional diet?

Compared to a conventional diet, the Mediterranean diet is effective in losing weight among overweight/obese individuals, patients with diabetes mellitus or metabolic syndrome, and postpartum women (Level of evidence A, strong recommendation; 94.5% agreement).

Huo et al[53] conducted a meta-analysis of nine RCTs that included 1,178 patients with T2DM, and the results showed that BMI, weight, HbA1c, fasting glucose, and fasting insulin levels were significantly lower in the Mediterranean diet group. Stendell-Hollis et al[54] conducted a four-month RCT on 129 overweight women at 17.5 weeks postpartum and found that participants in the Mediterranean diet group had significantly lower body weight and body fat content. Di Daniele et al[55] conducted a six-month Mediterranean diet intervention in 80 Italian patients with metabolic syndrome, and the results showed significant reductions in weight, BMI, waist circumference, LDL-C, and TG concentrations after the intervention. The four-week RCT in 188 Italian participants by Di Renzo et al.[56] found a significant reduction in body fat content in the Mediterranean diet group.

Meal replacement for weight loss

Meal replacements are specially processed and prepared calorie-restricted foods that meet the nutritional needs of adults for one or two meals during weight control to replace parts of meals. Various studies have shown that meal replacement as a dietary therapy is beneficial for weight loss.[57-59] Meanwhile, sustainable weight loss is obtained through meal replacement by reducing the variety of foods and controlling food portions. In addition, risk factors for obesity-related diseases may be improved, and the loss in lean body mass may be minimized, thereby maintaining strength and physical functions for long-term weight maintenance.[60]

Question 15: How to ensure adequate nutrition intake during weight loss with meal replacement? How safe is it?

Qualified meal replacement combined with multivitamin and mineral supplements should be chosen to ensure adequate nutrition intake during weight loss (Level of evidence C, weak recommendation; 94.5% agreement). The short-term application of meal replacement for weight loss is safe, with few serious adverse effects and favorable tolerability. The long-term safety remains to be further investigated (Level of evidence B, weak recommendation; 95.4% agreement).

Flechtner-Mors et al[61] conducted a prospective, randomized, two-arm parallel study with 100 participants. After four years of intervention, the results suggested that a structured diet plan using meal replacement with vitamin and mineral supplements is a safe and effective dietary strategy that also improves certain biomarkers of disease risks.

Coleman et al[60] conducted interventions with meal replacement food in 310 overweight/obese individuals for 24 weeks. The results showed that all adverse effects were mild, and the adverse effects with incidences > 5% were mainly gastrointestinal disorders or symptoms of hunger, fatigue, and stress/anxiety, with 2.9% of serious adverse events, including stroke, heart attack, cholecystectomy, and hospitalization for coagulation, hemorrhoids, and hyperthermia. In the 23 studies included in the systematic review by Astbury et al,[57] two studies reported adverse events, and no statistically significant differences were observed for intergroup comparisons of incidences of hypoglycemia, fracture, amputation, congestive heart failure, or gallstones among 5,145 participants. Noakes et al.[62] observed 66 overweight/obese individuals with elevated TG concentrations in a six-month intervention with meal replacement and a traditional, structured diet for weight loss. The meal replacement group maintained and enhanced the dietary nutritional adequacy during weight loss, and the participants had better adherence with easier access to food.

Question 16: What are the effects of weight loss with meal replacement on diabetes mellitus?

The short-term application of meal replacement in patients with T2DM may improve glycemia by reducing weight and, thus, blood glucose concentrations (Level of evidence B, weak recommendation; 92.8% agreement).

Cheskin et al[63] investigated the effects of meal replacement on weight loss in 112 patients with T2DM. The results showed that weight loss at 34 weeks of intervention and weight maintenance at 86 weeks were significantly better in the meal replacement group than in the standard diet group, with a higher percentage of participants having weight loss > 5% and higher maintenance rates in the meal replacement group. Brown et al.[64] conducted an RCT of 90 insulin-treated T2DM patients with obesity. After 12 months of intervention with a low-calorie meal replacement, the results showed greater weight loss in the meal replacement group, with a significantly lower proportion of patients on insulin therapy, and significantly higher proportions of patients who discontinued insulin therapy and had improved glycemic control, as well as improved quality of life, compared to the control group.

Question 17: How effective are meal replacements for weight loss in patients with metabolic syndrome and cardiovascular diseases?

The short-term use of meal replacement is effective in controlling weight and reducing risk factors for cardiovascular events in patients with metabolic syndrome and cardiovascular diseases (Level of evidence B, weak recommendation; 93.7% agreement).

The 24-week systematic retrospective cohort analysis of 310 overweight/obese individuals by Coleman et al[60] showed that decreases in blood pressure and heart rate occurred within the first four weeks of weight loss using meal replacements, with 38% of patients with prehypertension and 48% of patients with hypertension having a mean decrease in systolic pressure of 11.3±16.7 mmHg and a mean decrease in diastolic pressure of 6.6 ± 12.6 mmHg at week 12. The waist and hip circumferences were also decreased, and cardiovascular risk factors were improved. The RCT by Astbury et al[65] including 278 adults who were obese and seeking weight loss support showed that compared to the conventional weight loss with dieting + behavioral support groups, the complete meal replacement group had better effects in terms of weight loss, decreased risks of cardiometabolic diseases, and glycemic control. Moreover, compared to the control group, a significantly higher proportion of participants in the complete meal replacement group lost more than 10% of body weight.

Biorhythm and weight loss

Time-restricted feeding (TRF) refers to diets that restrict the time of daily food intake with fasting periods ranging from 3 to 21 hours, either during the day or at night.[66] There are three common types of restriction, namely feeding at 4-h, 6-h, and 8-h intervals. Compared to CRD, HPD, etc., TRF only limits the time of food intake, not the type or quantity of food, which makes it easier to practice, more acceptable, and easier to adhere to. Studies have shown that the short-term application of TRF interventions may lead to weight loss.[66-69] However, there have been mixed results on the effects of TRF on body composition. Currently, there is insufficient evidence to demonstrate the long-term effects of TRF on weight loss.

Question 18: What is the effect of TRF on lipid and glucose metabolism?

TRF may improve fasting glucose concentrations, but study results of the effects on insulin resistance and lipid metabolism have been inconsistent (Level of evidence D, weak recommendation; 90.7% agreement).

A systematic review that included 11 studies showed that TRF improved fasting glucose concentrations but had no significant effect on homeostatic model assessment for insulin resistance (HOMA-IR) and fasting insulin, TG, TC, HDL-c, and LDL-c concentrations.[66] Sutton et al.[70] conducted a five-week crossover RCT with equal calories in eight participants with prediabetes and obesity. The results showed that the TRF intervention decreased insulin levels and improved insulin sensitivity and pancreatic β-cell function while keeping the weight unchanged. However, no significant differences in fasting and postprandial glucose concentrations were observed.

Micronutrients

In addition to focusing on total energy and macronutrient ratios in MNTs for weight loss, micronutrient deficiencies require equal attention. Studies have shown that obese individuals are at a significantly higher risk of vitamin D deficiency than individuals with normal weight.[71] The risk of nutrient deficiency is increased in obese individuals on low-energy dietary interventions due to reduced total food intake or restricted food variety.

Question 19: Are micronutrient supplements required during medical nutrition therapy for weight loss? Are calcium, vitamin D, or iron supplements required?

In CRDs, especially interventions with very-low-calorie diets, multivitamins and micronutrients should be supplemented simultaneously (Level of evidence C, strong recommendation; 94.9% agreement). Individuals undergoing weight loss who are at risk of deficiencies should be supplemented with calcium or vitamin D (Level of evidence B, strong recommendation; 97.1% agreement). Individualized dietary regimens should be administered to prevent iron deficiency during MNT for weight loss (Level of evidence C, weak recommendation; 97.1% agreement).

CRDs, especially very-low-calorie diets may cause micronutrient deficiencies in obese individuals, with a higher risk of inadequate vitamin or micronutrient intake.[72] Micronutrient complex supplementation is required during weight loss with dietary interventions to prevent nutrient deficiencies due to restricted diets.

A prospective study of 136 patients before bariatric surgery found that 57% had varying degrees of vitamin D deficiency.[73] In a meta-analysis in 2019 that included 11 RCTs with a total of 947 patients, vitamin D supplementation was positively associated with decreases in both BMI and waist circumference after one to twelve months of vitamin D supplementation in combination with CRD and exercise.[74] One study investigated changes in micronutrient concentrations during a CRD intervention and found that 63% of women and 61% of men had inadequate calcium intake.[75] An RCT in 2004 found that weight and body fat content decreased more significantly during a CRD intervention for those on a high-calcium diet than those on a low-calcium diet and that calcium supplementation from dairy sources was more effective than that from nondairy sources.[76] The study by Teng et al.[77] showed that weight loss as a result of CRD interventions had a beneficial effect on the physiological homeostasis of iron in obese individuals. Long-term neglect of dietary iron intake during weight loss may lead to an increased risk of iron deficiency.

Intestinal microecology

Recent studies have shown that gut microbes play a role in metabolic regulation and food digestion. There is also a strong association between gut flora and obesity.[78,79] The metabolic activity of the gut flora may influence nutrient absorption and affect energy homeostasis between energy storage and expenditure by facilitating the energy metabolism of dietary components.[80,81] The pathogenesis of obesity also involves the influence of the intestinal flora on the regulation of energy metabolism and systemic inflammation. Metabolic diseases associated with obesity, such as T2DM and cardiovascular diseases, are also associated with gut flora.[82-84] Recent years have seen an increase in the clinical research on the use of probiotics, prebiotics, and fecal transplants for weight loss, targeting the intestinal microecology.[85-89]

Question 20: Is it possible to improve metabolic markers in obese adults through probiotic supplementation?

Adults who are obese may take probiotics containing specific strains of bacteria to assist in weight loss, thereby improving metabolic markers (Level of evidence C, weak recommendation; 91.1% agreement).

Bifidobacterium animalis subsp. lactis 420, in combination with polydextrose, may reduce body fat content and food intake in healthy overweight/obese individuals. Significant reductions in body weight and abdominal fat were observed compared to the placebo group. In obese adults, the body fat content in the group after 12 weeks of intervention with B. breve B-3 (2×10^{10} CFU/d) was significantly lower than that in the placebo group. After 12 weeks of daily administration of probiotic complex capsules UB0316 5×10^9 CFU and 100 mg of oligofructose, both BMI and waist-to-hip ratio were significantly lower in obese individuals.[90] A 12-week intervention using Lactobacillus gasseri BNR17 in 62 obese adults with BMI $\geq$23 kg/m^2 and fasting glucose $\geq$100 mg/dL showed a slight reduction in body weight but without significant difference. However, significant reductions in waist and hip circumferences were observed for participants in the *L. gasseri BNR17* group.[91]

Question 21: Can obese individuals with metabolic diseases such as nonalcoholic steatohepatitis and diabetes mellitus take probiotics containing specific strains of bacteria?

L. reuteri may help patients with nonalcoholic steatohepatitis lose weight, lower BMI, and decrease waist circumference. A weight loss diet combining a probiotic complex including *Lactobacilli*, *Bifidobacteria*, and *Streptococcus thermophilus* improves the BMI, insulin resistance, and appetite-related hormone concentrations in patients with metabolic syndrome (Level of evidence C, weak recommendation; 93.3% agreement).

In the study by Rabiei et al,[92] 46 adult patients with metabolic syndrome were given either probiotic complex or placebo capsules for three months, combined with an individualized weight loss diet. The results showed statistically significant differences in the mean changes in weight, BMI, HOMA-IR, as well as blood glucose, insulin, and GLP-1 concentrations between the two groups. In addition, the PYY concentration was significantly increased in the complex probiotic group, with a significant trend in weight loss by the end of the study. In an RCT of 50 patients with nonalcoholic steatohepatitis, patients were treated with 1×10^8 CFU of *L. reuteri* (containing guar gum and inulin) or placebo for three months. The results showed higher intestinal permeability but a lower prevalence of small intestinal bacterial overgrowth in patients with nonalcoholic steatohepatitis. After the intervention, patients in the probiotic group had reduced steatosis, as well as significantly lower weight, BMI, and waist circumference.[93]

Question 22: Can individuals on medical nutrition therapy for weight loss benefit from prebiotics?

Short-term intake of specific prebiotics or prebiotic-rich foods in obese children or adults may result in better weight loss outcomes (Level of evidence B, weak recommendation; 91.6% agreement).

Forty-two overweight/obese children aged 7-12 years received interventions with either oligofructose-rich inulin or placebo (doses with equal calories) once daily for 16 weeks, respectively. Children receiving inulin showed a significant decrease in the weight z-score by 3.1%, a significant decrease in body fat percentage by 2.4%, and a significant decrease in trunk fat percentage by 3.8%. A significant decrease in interleukin (IL)-6 concentrations from baseline, a significant decrease in serum TG concentrations, a significant increase in intestinal *Bifidobacteria*, and a decrease in *Bacteroides vulgatus* were also observed.[94] In another study, 48 overweight adults were randomly assigned to receive either an oligofructose or placebo (maltodextrin) intervention for 12 weeks, and the results showed that oligofructose supplementation was effective in reducing body weight, with a lower area under the curve for growth hormone-releasing peptide and a higher area under the curve for PYY among participants in the oligofructose group.[95]

Question 23: Is it possible to lose weight through fecal transplantation?

Routine weight loss by fecal transplantation is not recommended for obese individuals (Level of evidence C, weak recommendation; 89.0% agreement).

In one study, 22 obese (BMI ≥35 kg/m^2) individuals without a diagnosis of diabetes mellitus, nonalcoholic steatohepatitis, or metabolic syndrome were given either fecal transplant capsules or placebo capsules for 26 weeks, with the fecal transplant capsules coming from one donor with a lean body type (BMI 17.5 kg/m^2). The results showed no significant change in mean BMI at week 12 in either group.[96] The fecal microbiota transplantation trial for the improvement of metabolism (FMT-TRIM) was a single-center, 12-week, double-blind RCT of oral fecal transplant capsules in which 24 adults with obesity and mild-to-moderate insulin resistance (HOMA-IR, 2.0-8.0) were randomized to two groups and given either the fecal transplant capsules from healthy lean donors or placebo capsules. There was no statistically significant improvement in insulin sensitivity in the fecal microbiota transplantation group compared with the placebo group, with a mean difference of 9% between the two groups. However, there were differences in the colonization of donor intestinal bacteria in the fecal microbiota transplantation group, which persisted after 12 weeks, yet no clinically significant metabolic effects were observed.[97]

Medical nutrition therapy for weight loss and education

Multiple studies have shown that nutrition education increases the nutrition-related knowledge of individuals and groups[98,99] and changes their dietary structure, eating habits, and adherence,[99] to reduce energy intake,[99] increase physical activity,[100] lower blood lipids[100] and blood pressure,[100] as well as improve blood glucose concentrations, HbA1c concentrations, and pancreatic islet function, thereby causing weight loss as well as lowering BMI and obesity incidence.[98,99] In addition, nutrition education may significantly improve psychosocial related indicators. Nutrition education for obese individuals may significantly decrease their depression scores.[101]

Question 24: How to conduct nutrition education?

Online teaching of nutrition knowledge and provision of advice on nutrition, exercise, etc., can be provided through internet-based applets/mobile apps. Offline diet/nutrition counseling sessions, thematic sessions, etc., may be held to allow learning of nutrition knowledge and skills (Level of evidence C, strong recommendation; 96.6% agreement).

One study adopted a multimedia, interactive, and self-administered online intervention for three months which resulted in significant reductions in BMI, body fat content, and blood glucose concentrations in the study population.[102] Nutri-Expert is an electronic system for nutrition education. One study included 557 obese adults who were randomized to the traditional management group and the group using the Nutri-Expert system. Both nutrition education modalities significantly improved the participants' BMI, total cholesterol, LDL, apolipoprotein, and TG concentrations. However, participants using the Nutri-Expert system scored significantly higher on the dietary knowledge test than the group with conventional management.[103]

Medical nutrition therapy for weight loss and behavioral counseling

Behavioral counseling refers to a series of interventions that apply psychological and health behavioral principles to promote healthy behaviors and correct poor personal behavior.[104] It adopts behavioral sciences to analyze the characteristics of eating behaviors and exercise types of obese individuals, based on which better behaviors are fostered to help obese individuals establish a supportive environment for sustained behavioral change to ultimately achieve the purpose of weight loss.[104,105] Diverse approaches including regular team activities, knowledge learning, health action competitions, and interest groups may be used to encourage patients to adhere to good dietary and weight loss-related behaviors.[105-107]

Question 25: Who needs behavioral counseling in medical weight loss? How can the eating behaviors of obese adults be changed? Is specific behavioral counseling needed for specific weight loss populations?

Behavioral counseling should be given to all individuals on medical weight loss programs (Level of evidence A, strong recommendation; 95.6% agreement). For adult obese individuals, self-monitoring should be developed first, and the use of motivational interviewing, peer support, etc., may help with the change of eating behaviors (Level of evidence B, strong recommendation; 96.2% agreement). For those with severe obesity, patients after bariatric surgery, children and adolescents, as well as patients with polycystic ovary syndrome (PCOS), specific behavioral counseling may facilitate weight loss and its maintenance (Level of evidence B, strong recommendation; 96.6% agreement).

In 2018, a systematic review by the U.S. Preventive Services Task Force included 122 RCTs with a total of 62,533 patients and found that compared to the control group, interventions based on behavioral counseling resulted in more weight loss and less weight regain during 12 to 18 months.[108] The systematic review by Rudolph et al.[109] included 15 studies with a total of 1,008 patients, 13 of which showed more significant weight loss in participants receiving postoperative behavioral counseling than in those with general counseling. The systematic review by Burke et al[110] included 22 trials and found a significant association between self-monitoring and weight loss. The systematic review by Barnes et al[111] included 24 RCTs, nine of which had statistically significant differences in weight loss in the intervention group with motivational interviewing compared to the control group.

Hassan et al[112] conducted a systematic review of behavioral lifestyle interventions in individuals with severe obesity, which included 17 RCTs with a total of 7,981 patients. The results showed more weight loss in the behavioral intervention group. The systematic review by Livhits et al[113] included 10 prospective cohort trials with a total of 735 patients and found that participation in the postoperative support group was positively associated with the level of postoperative weight loss among patients. Several systematic reviews on the effect of behavioral counseling or intervention methods among children and adolescents have encouraged changes in eating behavior and physical activity in children and adolescents in combination with family support and nutrition education.[114,115] The RCT by Oberg et al.[116] that included 68 overweight/obese women with PCOS who received a four-month behavior modification intervention and completed a 12-month follow-up showed that at four months of the behavior modification intervention, significant weight loss was observed in women in the intervention group, with 54% of women having improved reproductive functions despite a mean weight loss of only 2%.

Question 26: Is it effective to use telemedicine for medical nutrition therapy for weight loss? Which populations are suitable for medical nutrition weight loss interventions guided by telemedicine?

MNT for weight loss using telemedicine may be effective for weight loss in adults, telemedicine interventions are recommended for at least six months, and the importance of post-intervention follow-up should be emphasized (Level of evidence B, strong recommendation; 93.7% agreement). Telemedicine-guided medical nutrition weight loss may provide a variety of interventions for a wide range of populations and may particularly increase participation in populations with certain conditions (e.g., mobility impairment, mental illness) (Level of evidence C, strong recommendation; 94.1% agreement).

In the RCT by Tarraga Marcos et al,[117] the test group received support from a telemedicine platform. Participants in both groups had decreased BMI after 12 months, with more weight loss among participants in the test group. A systematic review by Huang et al[118] included 25 RCTs with a total of 6,253 adults and interventions ranging from nine weeks to two years. The results showed statistically significant differences in BMI changes between participants in the telemedicine and control groups. It should be noted that significant reductions in BMI were only possible after a continuous six-month intervention. Telemedicine-guided MNT for weight loss produced favorable outcomes in terms of weight loss and weight loss maintenance by increasing participation and adherence to weight loss programs, which has made it effective not only for obese adults but also for overweight/obese children and elderly.[119,120] Young et al[121] conducted a study on 276 overweight individuals with severe mental illnesses, in which participants were randomized to three groups receiving WebMOVE, a computerized weight management and peer health coach, a weight management service guided by clinicians, and routine visits. At six months, participants in the WebMOVE group had lost 2.8 kg, and more than one-third of participants in the WebMOVE group had lost 5% or more of their body weight. The study findings suggested that this remote weight loss approach may also be effective for individuals with other specific conditions such as cognitive impairment.

Medical nutrition therapy for weight loss and drug therapy

Considering ethnic differences and the characteristics of the Chinese population, for individuals in the Chinese population with a BMI ≥28 kg/m^2 who fail to lose 5% of their body weight after three months of lifestyle interventions or individuals who have a BMI ≥24 kg/m^2 with one of the obesity-related complications, such as hyperglycemia, hypertension, dyslipidemia, MAFLD, pain of weight-bearing joints, or sleep apnea, drug treatment for weight loss is recommended based on lifestyle and behavioral interventions. The currently approved drug for weight loss in China includes orlistat. In June 2021, the US Food and Drug Administration approved semaglutide 2.4 mg injection as the world's first weekly injection of a GLP-1 receptor agonist for weight management in obesity.

Question 27: Does orlistat induce further weight loss in addition to personal behavior interventions such as diet or exercise?

The use of orlistat in addition to lifestyle interventions such as diet control, adjustment of physical activities, and behavioral interventions may result in further weight loss (Level of evidence A, strong recommendation; 89.5% agreement).

A 24-week multicenter RCT that included 123 overweight/obese individuals showed significant differences in mean weight loss, total body fat loss, and loss of visceral fat among participants in the orlistat group with low-fat CRD compared to the group with low-fat CRD alone.[122] Richelsen et al[123] conducted very-low-calorie diet interventions in 383 obese individuals, and significant weight loss was observed after eight weeks of intervention. Moreover, further weight loss was observed after three years in the group added with orlistat, and the number of new cases of T2DM in the orlistat group was significantly lower than that in the placebo group.

Question 28: How are the efficacy and safety of weight loss with currently available weight loss drugs?

Orlistat, the currently available drug for weight loss, may significantly decrease body weight and body fat tissue content when combined with a low-fat diet. The main adverse effects are gastrointestinal discomfort, including flatulence and steatorrhea. Daily oral multivitamin supplements, especially vitamin D, are recommended (Level of evidence B, strong recommendation; 90.7% agreement)

To assess the efficacy and tolerability of orlistat for weight loss therapy, Van Gaal et al[124] adopted a multicenter RCT design in which after a five-week placebo induction period, 676 obese individuals were randomized to receive three times per day the oral administration of orlistat at 30 mg, 60 mg, 120 mg, or 240 mg or the oral administration of matching placebos. After 24 weeks of continuous dosing, the mean weight losses were significantly higher in participants taking orlistat than in those taking the placebo, with participants in the orlistat 120 mg group having the greatest weight loss (9.8%) and favorable drug tolerance. The results of the 24-week RCT by Shirai et al[125] including 200 Japanese patients with excess visceral fat showed that the oral administration of 60 mg of orlistat at all three meals was significantly effective in reducing body weight and visceral fat content. Another study in 146 obese participants taking orlistat in combination with a low-calorie diet and exercise interventions showed significant reductions in body weight, systolic blood pressure, diastolic blood pressure, and LDL-C concentrations compared to the placebo group. The main adverse drug reactions were gastrointestinal reactions, which were mild and resolved on their own. Therefore, none of the participants dropped out halfway through the study.[126] In several cohort studies in adolescents with obesity, 1/3 of the participants discontinued the drug due to gastrointestinal reactions.[127] Some participants still developed vitamin D deficiency despite taking multivitamin supplements containing vitamin D.[128]

Question 29: What are the choices of medication to help with weight loss for overweight/obese patients with T2DM?

Metformin, a first-line treatment for T2DM, is indicated for overweight/obese patients with T2DM and contributes to weight loss (Level of evidence A, strong recommendation; 94.9% agreement). GLP-1 receptor agonists are clearly beneficial for weight loss in overweight/obese patients with T2DM (Level of evidence A, strong recommendation; 94.9% agreement). Sodium-glucose cotransporter-2 (SGLT-2) inhibitors may lead to weight loss in patients with diabetes mellitus while controlling blood glucose concentrations (Level of evidence A, strong recommendation; 94.1% agreement). Dipeptidyl peptidase-4 (DPP-4) inhibitors and α-glucosidase inhibitors have indefinite effects on weight loss in the treatment of patients with diabetes and are currently considered to have a neutral effect on body weight (Level of evidence B, weak recommendation; 94.1% agreement).

An RCT included 48 T2DM patients with obesity who were given metformin or placebo for 24 weeks along with dietary control. The results showed that patients in the metformin group had 8 kg more mean maximum weight loss than those in the placebo group, as well as lower HbA1c and fasting glucose concentrations after treatment. In addition, appetite suppression with metformin showed a dose-response relationship.[129] The Diabetes Prevention Program study included 3,234 overweight/obese hyperglycemic patients who were randomized to the metformin group, lifestyle management group, and control group. After 15 years of follow-up, the metformin group had the most considerable weight loss (6.2%), while weight losses were 3.7% in the lifestyle management group and 2.8% in the control group, which also suggested that metformin induced more substantial and sustained weight loss than lifestyle management.[130]

A systematic review analyzed the efficacy of GLP-1 receptor agonists versus other oral hypoglycemic agents or insulin in patients with T2DM and found that GLP-1 receptor agonists produced a more significant effect on weight loss.[131] Among obese individuals without T2DM, those who received continuous treatments with 2.4 mg of semaglutide injection for 68 weeks had a mean weight loss of 17-18%.[132-134] The treatment was also shown to be safe and well tolerated, with gastrointestinal events being the most common adverse event.

SGLT-2 inhibitors reduce blood glucose concentrations by reducing renal reabsorption of glucose and increasing glucose excretion. Energy loss was accompanied by the excretion of glucose from the urine (approximately 300 kcal/d), which resulted in weight loss.[135]

Another RCT included 252 patients with T2DM and moderate renal impairment. After the administration of 5 mg or 10 mg of dapagliflozin, patients had a mean weight loss of 1.54 kg or 1.89 kg, respectively, while the patients in the placebo group had a mean weight gain of 0.21 kg.[136]

Current clinical studies concluded that DPP-4 inhibitors have a neutral effect on weight change among patients with T2DM.135 The weight change in T2DM patients treated with DPP-4 inhibitors ranged from -0.09 to +1.11 kg.[137] α-glucosidase inhibitors may delay the absorption of carbohydrates in the gastrointestinal tract, thereby lowering the postprandial glucose spike. The Consensus Statement by the American Association of Clinical Endocrinologists and American College of Endocrinology (AACE/ACE) on the Comprehensive Type 2 Diabetes Management Algorithm considered the effect of α-glucosidase inhibitors on body weight to be neutral,[138] with studies assessing the effect of α-glucosidase inhibitors on body weight change to range from -1.80 to -0.43 kg.[137]

Nutrition issues related to bariatric and metabolic surgeries

Bariatric/metabolic surgery is a surgical or endoscopic approach to alter the anatomy or connectivity of the gastrointestinal tract to regulate nutrient intake, absorption, and metabolic conversion to decrease body weight, reverse obesity-related metabolic disorders, and reduce the incidence of cardiovascular and cerebrovascular events, thereby improving the quality of life and increasing life expectancy. Current surgical modalities for weight loss that are supported by various clinical lines of evidence and are formally recognized by multiple national societies include sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), and a combination of these procedures.

Question 30: Is preoperative weight loss through diet restriction required for patients to receive bariatric surgery?

All patients to receive bariatric surgery should be subject to preoperative weight loss through diet restriction (Level of evidence B, strong recommendation; 95.4% agreement).

The benefits of preoperative weight loss prior to bariatric surgery are substantial with sufficient evidence. Preoperative weight loss may not only reduce the body weight,[139,140] but also liver volume and visceral fat content,[141-148] as well as surgical risk, intraoperative bleeding, and operative time.[140,149] Preoperative weight loss goals may be set based on an excess weight loss (EWL) of ≥ 8%, and studies have found that higher percentages of total preoperative weight loss were associated with higher percentages of postoperative weight loss and shorter operative times.[150] A two-week RCT showed that a very-low-calorie diet reduced surgical difficulties and lowered the conversion rate from laparoscopy to open surgery.[149] In particular, for patients with a BMI > 50 kg/m^2, some prospective studies have recommended the use of a very-low-calorie diet.[141,142]

Question 31: What nutritional management strategies should be adopted in the perioperative period?

The perioperative nutritional management of bariatric surgery should involve a multidisciplinary team (MDT), which should be adopted throughout the preoperative assessment, intraoperative monitoring, postoperative rehabilitation, and postoperative follow-up (Level of evidence C, strong recommendation; 96.2% agreement). For the nutritional intake after bariatric surgery, a negative energy balance of the body should be maintained while ensuring adequate intake of protein and other nutrients. The required nutrients should be supplemented after various procedures to reduce the risk of malnutrition-related complications (Level of evidence B, strong recommendation; 96.6% agreement). The application of the concept of enhanced recovery after surgery (ERAS) to the comprehensive perioperative nutritional management of bariatric surgery may provide additional benefits to patients (Level of evidence B, strong recommendation; 96.6% agreement).

Preoperative weight loss should be performed from an MDT perspective, and regular postoperative follow-ups should be made according to the plan developed in-hospital with the participation of MDT specialists, with frequencies depending on the surgical approach and comorbidities. Moreover, routine metabolic and nutritional monitoring should be performed.[151] Bariatric surgeons, endocrinologists, clinical dietitians, and psychiatrists should be MDT core members, with the aims of identifying surgical indications, screening for contraindications to surgery, assessing surgical risks, and performing preoperative interventions to reduce surgical risks.[152,153]

SG does not change the intestinal structure, and the risk of postoperative malnutrition is relatively low. Common nutrition-related complications of SG include gastroesophageal reflux, vomiting, inadequate protein intake, nutritional iron deficiency, calcium and vitamin D deficiencies, vitamin B-12 and folate deficiencies, and deficiencies of micronutrients such as zinc and magnesium.[154,155] RYGB is associated with risks of dumping syndrome and steatorrhea. Therefore, postoperative intake of fat and refined carbohydrates should be limited as appropriate, and the intake of monosaccharides should be avoided, while the intake of fiber and complex carbohydrates should be increased.[156] The recommended protein intake for patients receiving bariatric surgery is 60-80 g/d.[157] Within three to six months after RYGB and SG, all daily nutritional supplements may be given via regular oral food intake, while vitamin B-12 may be administered intramuscularly to maintain normal levels.[158]

In an RCT that included 80 patients receiving SG, patients in the ERAS group had significantly shorter postoperative hospitalization duration, nasogastric tube duration, time of intestinal gas passing, and time to postoperative food intake, as well as significantly less pain than the control group.[159]

Question 32: How to prevent malnutrition and related complications after bariatric surgery?

Adequate amounts of protein should be supplemented after weight loss surgery (Level of evidence B, strong recommendation; 94.5% agreement). Vitamin D concentrations and bone densities should be determined for all patients after bariatric surgery, and 3,000 U/d of prophylactic oral vitamin D3 is recommended. The calcium intake requirement is 1,200-1,500 mg/d (Level of evidence B, strong recommendation; 94.5% agreement). Routine supplementation with 350-1,000 μg/d of vitamin B-12 is required for patients after bariatric surgery. For patients with preexisting vitamin B-12 deficiency, daily supplementation with 1,000 μg is required until the index returns to normal, which should be maintained with the recommended dose (Level of evidence B, strong recommendation; 93.4% agreement).

Indicators of iron metabolism should be routinely monitored after bariatric surgery, and iron supplements with vitamin C should be administered immediately in the event of iron deficiency anemia (Level of evidence B, strong recommendation; 95.4% agreement).

In a study that included 244 Chinese obese individuals receiving SG or RYGB, the incidences of hypoalbuminemia at one year postoperatively were 1.2% and 8.9%, respectively.[160] In the Guidelines for Perioperative Care in Bariatric Surgery: Enhanced Recovery After Surgery (ERAS) by Thorell et al,[161] the recommended postoperative protein intake was 60-120 g/d. Clifton et al[162] examined the long-term effects of HPD on weight loss and found that the higher the protein content recorded in the diet, the greater the weight loss, as well as the improvement in indicators such as blood lipid, glucose, C-reactive protein, and homocysteine concentrations.

A retrospective study of Chinese patients with obesity found that the prevalence rates of vitamin D deficiency within one year after SG and RYGB were 42.7% and 65.8%, respectively.[163] The Clinical Practice Guidelines for Perioperative Nutritional, Metabolic, and Nonsurgical Support of the Bariatric Surgery Patient (2019 Update) (hereafter referred to as the US Guidelines), which was co-authored by the AACE, The Obesity Society, and the American Society for Metabolic and Bariatric Surgery (ASMBS), recommends that all bariatric surgery patients should be screened for vitamin D deficiency and receive prophylactic oral administration of vitamin D3 at 3,000 U/d. Calcium intake (diet versus calcium supplementation) depends on the surgical procedure, and the dose requirement for patients after SG and RYGB was 1,200-1,500 mg/d.[152]

A retrospective study of Chinese obese individuals found that the prevalence rates of vitamin B-12 deficiency within one year after SG and RYGB were 7.3% and 25.3%, respectively.[160] As such, the US Guidelines recommend that after bariatric surgery, all patients should receive 350-1,000 μg of vitamin B-12 supplements daily or 1,000 μg per month if supplemented via intramuscular or subcutaneous injections. For patients with an existing vitamin B-12 deficiency, 1,000 μg of vitamin B-12 should be supplemented daily until the concentration returns to normal values, which should then be maintained with the recommended dose.[152]

Vitamin B-1 may be supplemented as needed after bariatric surgery. For patients with a preexisting vitamin B-1 deficiency, an oral supplementation dose of 200 mg/d should be administered until symptom resolution or 200-500 mg/d until symptom resolution if supplemented via the intravenous or subcutaneous routes, which should then be maintained at an oral dose of 100 mg/d (Level of evidence B, weak recommendation; 94.5% agreement). A prospective study including 151 patients after RYGB reported a prevalence of vitamin B-1 deficiency of 18%, with a mean time to symptom onset of five years postoperatively. The symptoms in nearly half of these patients with vitamin B-1 deficiency manifested as constipation, and the symptoms resolved with vitamin B-1 supplementation.[164] Lin et al.[160] found that the incidence rates of anemia within one year after SG and RYGB were 4.8% and 22.8%, respectively. In addition, the iron metabolism of patients after bariatric surgery should be monitored regularly. Once iron deficiency anemia is observed, iron and vitamin C should be supplemented promptly; drugs include ferrous sulfate, iron(II) fumarate, and iron gluconate at a recommended oral dose of 150-200 mg/d.[153]

Question 33: How to prevent inadequate weight loss or weight regain after bariatric surgery?

For nutritional interventions in individuals who have lost insufficient weight or regained weight after bariatric surgery, dietary modification may be administered with increased protein ratios, and personal behavioral changes should be made as recommended in the Guidelines (Level of evidence A, strong recommendation; 95.8% agreement).

Inadequate postoperative weight loss is defined as an EWL of less than 50% at 12 months or 18 months after bariatric surgery.[165] Weight regain is defined as a gradual weight gain after initial weight loss to an EWL >50%. In a study of 30 patients who regained weight after RYGB with a two-month calorie restriction management, 82.5% of the patients lost weight, and weight losses ranged from 2.3% to 10.8%.[166] The RCT by Lopes Gomes et al[167] included 34 female patients who had regained weight after RYGB surgery with postoperative whey protein supplementation for 16 weeks. The results showed a significant reduction in body weight and body fat content in the intervention group. Faria et al.[166] performed three months of low GI/GL nutritional therapy in 30 patients who regained weight postoperatively, and the results showed that 86% of the patients lost weight, with more than half of the patients reaching the 50% EWL criterion again.

Weight maintenance after medical weight loss

Overweight/obese adults may lose on average 13% of their body weight in four months, but approximately 48% of them experienced weight regain at 21 months.[168] Factors contributing to weight regain include unrestricted eating behaviors, negative emotions and stress, as well as negative reactions to difficulties in weight loss.[169] Therefore, participation in long-term comprehensive weight loss maintenance programs after successful weight loss and follow-up visits using traditional face-to-face or internet approaches are important.[170,171]

Question 34: How to develop a diet plan for the maintenance phase after weight loss?

A calorie-restricted HPD for three to six months is helpful for weight maintenance (Level of evidence B, strong recommendation; 95.4% agreement).

A multicenter RCT that included 538 participants from eight European countries who completed more than six months of follow-up showed that participants in the high protein intake group had less weight regain than those in the normal protein intake group.[172] Soenen et al[173] included 132 participants and randomized them by macronutrient percentages to a high-protein low-carbohydrate diet group, a high-protein normal-carbohydrate diet group, a normal-protein low-carbohydrate diet group, and a normal-protein normal-carbohydrate diet group. CRD interventions were performed during both the three-month weight loss phase and the nine-month maintenance phase. The results showed that better weight loss and maintenance outcomes depended on the "high protein" rather than the "low carbohydrate" component but were independent of the fat content. The study by Trepanowski et al[174] included 100 participants that were randomly assigned to the alternate-day fasting group, continuous calorie restriction group, or control group without intervention. The trial included a six-month weight loss phase and a six-month maintenance phase. The results showed that compared to the control group without interventions, participants in the alternate-day fasting group and the continuous calorie restriction group had similar results during the weight maintenance phase. The study by Headland et al[175] included 332 participants that were randomized to a continuous calorie restriction group, an alternate week energy restriction group, and a 5:2 intermittent fasting group. The trial included an eight-week intensive phase and a 12-month weight loss maintenance phase, and the results showed similar levels of weight loss in the three groups at the end of the study.

Question 35: How long should follow-up management last after weight loss?

Participation in a long-term (≥1 year) comprehensive weight loss maintenance program after weight loss increases the likelihood to maintain the weight loss. (Level of evidence C, strong recommendation; 96.6% agreement).

A systematic review and meta-analysis published by Middleton et al[176] included 11 studies, and the results showed that those who received face-to-face or telephone follow-ups after weight loss lost on average an additional 3.2 kg over 17.6 months compared to the group without follow-ups. Dutton et al[177] conducted a 12-month weight maintenance program in 108 participants who lost ≥5% of their body weight by randomizing them to a clustered campaign treatment group and a self- directed group. The results showed that participants in the clustered campaign treatment group regained significantly less weight than those in the self-directed group.

Question 36: How can adherence to lifestyle management during weight loss maintenance be improved?

Adherence to lifestyle management may be improved through behavioral intervention strategies during the weight loss maintenance phase to produce favorable weight loss outcomes (Level of evidence B, strong recommendation; 96.6% agreement).

The study by Madigan et al.[178] showed that those who weighed themselves regularly had less weight regain during the one-year weight loss maintenance phase than those who did not weigh themselves regularly. Wing et al[179] randomly selected 314 individuals, who successfully had lost weight, and implemented a self-monitoring program using face-to-face or internet approaches. The results showed that the self-monitoring program that included daily self-weighing was more helpful in reducing weight regain when implemented face-to-face. The systematic review and meta-analysis by Burgess et al.[180] showed that behavioral intervention strategies such as goal setting, problem-solving, and stimulus control improved patient adherence and compliance to lifestyle management programs.

Precision nutrition and medical weight loss

With the development of modern technologies such as intelligent information technology and genetics, precision nutrition, a truly individualized and dynamic nutrition program designed to collect, integrate, and analyze data of individual genes, environment, lifestyle habits, and other information, was established.[181] Studies have shown that individualized nutrition intervention programs were more effective than standard programs in losing weight[182,183] and that diet adjustment based on genetic testing results also provided certain advantages.[184,185] However, more evidence is needed to support the sole use of genotypes to guide weight loss.[186] The integration of various genotypic and phenotypic analyses to guide weight loss is shown to be more promising.

Question 37: Are precision nutrition programs beneficial in achieving weight loss goals?

Obese individuals who have difficulties achieving weight loss goals with conventional treatment methods may be considered for obesity-related genetic testing and corresponding dietary interventions (Level of evidence D, weak recommendation; 90.7% agreement). Diets rich in dietary fibers may result in better weight loss outcomes in people with high *Prevotella*/*Bacteroidetes* (P/B) ratios (Level of evidence B, strong recommendation; 94.1% agreement).

An RCT included 742 obese adult patients with the RS1558902 variant of the FTO gene who were given four different diets. The results demonstrated that the administration of an HPD helped the patients lose more weight and improved body composition, as well as fat distribution.[187] The Food4Me study conducted in Europe included 683 overweight patients, and the reductions in weight and waist circumferences were more pronounced compared to controls after individualized interventions based on the FTO RS9939309 allele AT/AA carried by overweight patients.[188]

A 26-week intervention with a new Nordic diet (NND), which had high fiber/whole grain content, or an average Danish diet (ADD) was performed in 62 individuals with increased waist circumference, respectively. The NND approach decreased more significantly the visceral fat content among participants with high intestinal P/B ratios, whereas no differences were observed in those with low P/B ratios.[189] A diet of 500 kcal/d supplemented with high (calcium ~ 1,500 mg/d) or low (calcium ≤600 mg/d) micronutrient components was selected for 80 overweight individuals for 24 weeks. The results showed more significant weight loss in individuals with high P/B ratios compared to those with low P/B ratios. The partial correlation coefficient between fiber intake and weight change was 0.90 in participants with high P/B ratios but only 0.25 in those with low P/B ratios, which confirmed that it was easier for those with high P/B ratios to lose weight on fiber-rich diets.[190]

Exercise and medical nutrition therapy for weight loss

The lack of physical activity is one of the important risk factors for overweight/obesity. Exercise may be used to achieve a negative energy balance by increasing energy expenditure. Numerous studies have shown that exercise may lead to decreases in weight, waist circumference, and body fat in overweight/obese individuals.[191-193] Exercise should be an important cornerstone of MNT for weight loss.

Question 38: Is there a dose-response relationship between exercise and weight loss?

There is a significant dose-response relationship between exercise and weight loss. Overweight and obese individuals should exercise at least 150 min per week with moderate intensity for moderate weight loss. For a weight loss of ≥5%, individuals should exercise 300 min per week at a moderate-to-high intensity or with an energy expenditure of ≥2,000 kcal/week through exercises (Level of evidence A, strong recommendation; 95.8% agreement).

For overweight/obese individuals, exercise at moderate intensity should be gradually increased from at least 150 min/week (30 min/d) to 300 min/week (60 min/d).[194] A systematic review that included 64 RCTs showed a significant dose-response relationship between exercise and changes in body weight and body composition. Exercise of more than 120 min/week resulted in significant improvements in body composition (with a moderate effect size or above). Exercise at moderate intensity resulted in significantly better improvements in BMI, body fat content, and waist circumference than low- and high-intensity exercises.[192] The results of an RCT by Slentz et al[195] on the intervention of exercise in overweight/obese individuals aged 40-65 years showed a significant dose-response relationship between exercise and decreases in weight and fat.

Question 39: What type of exercise is the most effective in losing weight?

Aerobic exercise combined with resistance training is recommended as a form of exercise for weight loss (Level of evidence A, strong recommendation; 95.8% agreement). Compared with moderate-intensity continuous training (MICT), high-intensity interval training (HIIT) may be used as a form of exercise for weight loss, fat loss, and cardiopulmonary function improvement, with the advantage of being time-efficient (Level of evidence C, weak recommendation; 95.4% agreement). For individuals with poor compliance to exercise activities, multiple short exercises may be performed using fragmented time, and the accumulation may result in even better weight loss outcomes than one continuous long exercise with the same amount of exercise (Level of evidence B, weak recommendation; 92.4% agreement).

The meta-analysis by O'Donoghue et al.[196] included 45 RCTs with 3,566 overweight/obese individuals. The results showed that the weight loss of participants in the intervention group (high-intensity aerobic exercise + high-load resistance training) was significantly better than that of participants in the control group and the group with resistance training alone. Moreover, the reduction in abdominal fat, the increase in lean body mass, and the improvement in cardiorespiratory fitness were all better in the group with high-intensity, high-load training than in those with other forms of exercise. The results of the eight-month Studies of a Targeted Risk Reduction Intervention Through Defined Exercise with aerobic training/resistance training (STRRIDE AT/RT) trial by Willis et al.[197] showed that participants in the aerobic training and aerobic + resistance training groups lost significantly more weight and fat than those in the group with resistance training alone and that the increases in lean body mass among participants in the aerobic + resistance training and the resistance training groups were both significantly higher than that in the group with aerobic training alone.

The meta-analysis by Viana et al[198] comparing the fat loss effects of HIIT and MICT showed that both exercise methods significantly reduced body fat content and lowered the absolute fat mass. However, HIIT was more advantageous than MICT in terms of lowering absolute fat mass. Meta-analyses by Türk et al[199] and Jelleyman et al[200] reported that HIIT was able to save approximately 40% of exercise time, suggesting a time-efficiency advantage of HIIT.

Madjd et al[201] conducted a six-month RCT with 300 min of exercise per week for six days per week, with one group exercising 50 min once a day and the other group exercising 25 min twice a day. The results showed that weight loss was significantly better in the group with 25 min per exercise twice a day than in the group with 50 min once a day. The RCT of Alizadeh et al.[202] also supported this conclusion.

Psychotherapy and medical nutrition therapy for weight loss

Epidemiological surveys showed that the prevalence rates of overweight/obesity were approximately 30%, 30-70%, and 20-50% among patients with bipolar disorder, schizophrenia, and depression, respectively.[203-205] Anxiety symptoms were also considered to be highly correlated with obesity but with great heterogeneity among studies.[206-209] Another type of psychiatric disorder that is highly correlated with obesity is binge-eating disorder, which is also often comorbid with bipolar, depressive, and anxiety disorders.[210] Psychotherapy, by improving the psychological factors of the patient's unhealthy eating habits, allows for better implementation of diet plans and behavioral training for weight loss, thus exerting a multiplier effect on weight control and BMI reduction.

Question 40: Which types of patients should receive psychotherapy during medical therapy for weight loss?

Obese individuals with symptoms of psychiatric disorders, particularly anxiety, depression, and binge-eating behaviors, should receive psychotherapy in conjunction with medical therapy for weight loss (Level of evidence B, strong recommendation; 95.8% agreement).

Munsch et al[211] conducted an RCT of cognitive and behavioral therapies for weight loss in 80 patients with binge-eating disorder. The results showed that binge-eating behaviors were improved more rapidly in the cognitive therapy group, whereas BMI was reduced more rapidly in the behavioral therapy group for weight loss. No significant difference was observed between the two treatment methods in the 12-month long-term follow-up. Grilo et al[212] randomly assigned 90 patients with binge-eating disorder to a 12-week intervention in a cognitive-behavioral therapy group, a behavioral therapy group for weight loss, and a blank control group. The results showed that patients in the cognitive-behavioral therapy group had the best compliance and improvement in binge-eating behavior but with no advantage in BMI reduction in the short term.

Question 41: Can cognitive therapy assist patients in medical weight loss?

Cognitive therapy may assist in the treatment of obesity caused by binge-eating disorder and may also be integrated with other psychotherapeutic approaches such as interpersonal therapy and mindfulness-based cognitive therapy (Level of evidence B, weak recommendation; 94.1% agreement).

At present, several studies have confirmed the effectiveness of cognitive-behavioral therapy in alleviating binge-eating behaviors.[211-213] The study by Spadaro et al.[214] showed that the addition of a six-month mindfulness-based cognitive therapy to a traditional behavioral weight loss program resulted in the development of better eating habits and reduced the average weight of participants. The meta-analysis by Sala et al.[215] confirmed that mindfulness was negatively associated with the psychopathology of eating disorders, which provided a theoretical basis for mindfulness-based cognitive therapy for weight loss.

Medical nutrition therapy for weight loss and nutritional supplements

Nutritional supplements should be recognized rationally and applied precisely in clinical practice in a scientifically sound manner with the support of high-quality evidence-based medical research. In these Guidelines, a comprehensive search of clinical studies on the effects of four health ingredients, namely fish oil, medium-chain triglyceride (MCT), L-carnitine, and resistant starch (RS) on MNT for weight loss was conducted to extract, analyze, and grade the evidence for the appropriate selection and application of these nutritional ingredients.

Question 42: Does fish oil, as a dietary supplement, help overweight/obese individuals to obtain better weight loss outcomes?

Evidence for weight and body fat improvement in overweight/obese individuals with the use of fish oil preparations alone is insufficient. However, fish oil preparations may improve waist circumference, waist-to-hip ratio, and lipid profile (Level of evidence B, weak recommendation; 94.9% agreement).

The systematic review by Du et al[216] included 21 RCTs with 1,652 overweight/obese adults, and the results showed no improvement in body weight with fish oil intake alone or fish oil combined with diet and exercise. However, fish oil with a weight loss diet significantly reduced both waist circumference and waist-to-hip ratio. The RCT by Munro et al.[217]

demonstrated that fish oil supplementation (4.2 g/d) combined with CRD improved both body weight and blood lipids in obese individuals.

Question 43: Does MCT help overweight/obese individuals to lose weight?

Moderate supplementation with MCT and its continuous use for more than 12 weeks may help with weight loss in overweight/obese individuals (Level of evidence C, weak recommendation; 92.0% agreement).

The systematic review and meta-analysis by Mumme et al[218] which included 13 studies with 749 participants showed that MCT intake may reduce body weight and waist circumference. The RCT by Han et al[219] included 40 Chinese overweight patients with T2DM, in which patients in the MCT group took MCT at 18 g/d for an intervention of 90 days, while patients in the long-chain triglyceride group took corn oil at 18 g/d. The results showed significant reductions in body weight and waist circumference in the MCT group.

Question 44: Does L-carnitine reduce weight and improve body composition?

Intake of 2-3 g of L-carnitine per day for eight weeks or more may help with weight loss (Level of evidence C, weak recommendation; 89.5% agreement).

The systematic review by Askarpour et al[220] included 43 RCT studies with 2,703 healthy obese individuals to investigate the effects of L-carnitine on body composition. The results showed that both L-carnitine supplementation alone or in combination with lifestyle interventions significantly reduced body weight and BMI. Subgroup analysis showed that L-carnitine supplementation alone also significantly reduced the waist circumference in obese individuals, and a trend of further decreases in BMI was observed with further increases in L-carnitine intake. Multiple lines of evidence support the daily intake of 2-3 g of L-carnitine for weight loss purposes and suggest that an intervention for eight to ten weeks produces favorable outcomes. The systematic review by Talenezhad et al[221] investigated the effects of L-carnitine on body weight, and the results showed that L-carnitine supplements significantly reduced body weight and BMI compared to the control group but without a significant effect on waist circumference.

Question 45: Does RS intake during weight loss improve the outcomes of weight loss, blood glucose concentration, insulin sensitivity, and lipid profiles in overweight/obese individuals?

Intake of RS during weight loss may help to improve weight and body composition in overweight/obese individuals, while also potentially improving blood lipid profiles, blood glucose concentrations, and insulin sensitivity (Level of evidence C, weak recommendation; 94.5% agreement).

The RCT by Nichenametla et al[222] included 86 individuals for an intervention of 26 weeks. The addition of 30% (v/v) of RS type 4 to the flour failed to significantly improve body weight and BMI but significantly increased lean body mass and reduced body fat content. Meanwhile, it also significantly reduced body fat content and waist circumference in participants without metabolic syndrome, as well as TC, non-HDL, and HDL-c concentrations in patients with metabolic syndrome. However, no significant improvements were observed in fasting glucose, postprandial blood glucose, LDL-c, and TG concentrations. Johnstone et al.[223] conducted an RCT in which participants were randomized into two groups at the end of a 21-day high-protein weight loss diet, with one group continuing the weight maintenance diet regimen and the other group having this regimen with added RS type 3. The results showed significant reductions in fasting glucose concentrations in both groups but no significant improvement in waist circumference, hip circumference, or lipid concentrations. The results from the RCT by Johnston et al[224] showed that the intake of RS type 2 (40 g/d) significantly improved insulin sensitivity in patients with metabolic syndrome, but a significant improvement in HOMA was not observed.

Beverages and medical nutrition therapy for weight loss

Coffee and medical nutrition therapy for weight loss

Low-to-moderate doses of caffeine may stimulate neuronal activity in several brain regions by increasing norepinephrine and dopamine release[225] and may also increase fat oxidation by inhibiting phosphodiesterase and antagonizing the effect of adenosine on norepinephrine release.[226] Chlorogenic acid is the main phenolic component with antioxidant properties in green coffee extract. The consumption of green coffee extract or chlorogenic acid may inhibit fat accumulation,[227] lower body weight and blood pressure, as well as regulate postprandial glucose metabolism by reducing intestinal absorption.[228] Mannan oligosaccharides, another coffee extract, may facilitate the improvements in body composition by reducing visceral fat and subcutaneous fat.[229]

Question 46: Can coffee or coffee extract beverages help with weight loss?

Coffee or coffee extract beverages may contribute to weight loss, decrease body fat content, and help to maintain weight loss outcomes (Level of evidence C, weak recommendation; 86.9% agreement).

A systematic review included 13 studies with 606 participants and interventions of 4-36 weeks. The results showed that compared to participants who consumed 1 mg/kg of caffeine per day, participants who consumed 2 mg/kg of caffeine per day had a 22% reduction in body weight, a 17% reduction in BMI, and a 28% reduction in body fat content.[230] One RCT included 60 overweight/obese individuals and compared the effects of a calorie-shifting diet (CSD) and CSD + caffeine (oral intake of 5 mg/kg/d) for six weeks. The results showed greater reductions in body weight and body fat content among participants in the CSD + caffeine group.[231] Observations at four weeks of the maintenance phase after weight loss revealed that the weight of participants in the CSD + caffeine group was still on the decline.

Sweeteners and medical nutrition therapy for weight loss

Excessive sugar intake is one of the dietary factors that contribute to obesity in modern society. Alternatives to sucrose have received more attention than ever before. It is essential to develop economical and safe sweeteners to replace sugar.

Question 47: How does the consumption of beverages containing sucrose or artificial sweeteners affect weight and blood sugar concentration?

A high intake of sucrose-containing beverages is more likely to increase energy intake, body weight, and fat content. Artificial sweeteners may contribute to weight loss, but the long-term safety remains to be evaluated (Level of evidence B, weak recommendation; 91.1% agreement).

Raben et al[232] randomized participants into groups to compare the effects of sucrose and artificial sweeteners on food intake and body weight in overweight individuals. The results showed that participants in the sucrose group had increased body weight and fat content, while participants in the artificial sweetener group had considerable decreases in these parameters, with statistically significant differences in all intergroup comparisons. A total of 154 overweight or obese adults were selected to compare the effects of the consumption of four oligosaccharides and sucrose on body weight, food intake behavior, and glucose tolerance. Participants were randomly assigned to consume beverages containing any one of the five sweeteners (sucrose, saccharin, aspartame, rebaudioside A, or sucralose) for 12 weeks. The results showed that all participants in the sucrose and saccharin groups significantly gained body weight, while there was no significant change in body weight in the aspartame, rebaudioside A, and sucralose groups.[233]

Question 48: Do non-nutritive sweeteners (NNSs) help obese individuals to lose weight?

Compared to sucrose-containing beverages, NNS-containing beverages were associated with certain weight loss effects in obese individuals. However, water is still recommended as a regular drink for weight loss (Level of evidence B, strong recommendation; 92.4% agreement).

The findings of a systematic review and systematic evaluation that included 20 studies with 2,914 obese individuals showed that interventions lasting at least four weeks resulted in a reduction in weight/BMI in participants receiving NNSs compared to those not receiving NNSs. The use of NNSs to replace sucrose resulted in weight loss, particularly in overweight/obese individuals who did not wish to restrict their diet.[234] An RCT included 148 nurses and randomized them into three groups: one group was not allowed to consume sugary drinks, only plain water, tea, or unsweetened coffee; one group was allowed to consume drinks with NNS; and one group had no restrictions on sugary drinks. The results showed greater reductions in weight, hip circumference, and sodium intake in the group with no consumption of sweetened beverages. In comparison, participants in the NNS group lost less weight than the former and tended to increase carbohydrate intake.[235]

SPECIFIC POPULATIONS

Medical nutrition therapy for weight loss in severely obese individuals

A BMI ≥ 37.5 kg/m^2 (or a BMI ≥ 32.5 kg/m^2 in the presence of comorbidities) is called severe obesity, in which case health risks increase with weight gain. Weight loss may help reduce the risk of complications.[236,237] Individuals with severe obesity should receive aggressive treatment including intensive comprehensive lifestyle interventions, pharmacotherapy, and metabolic surgery. Although metabolic surgery remains the most effective way to lose weight and maintain weight loss as well as improve comorbidities and mortality,[238,239] personal behavior interventions are recommended as the basis for weight loss and the treatment of obesity-related comorbidities.

Question 49: How can the target energy for nutritional intervention be set for severely obese individuals?

Daily intake during weight loss in severely obese individuals may be set as an energy reduction of 400-600 kcal/d or a low-energy intake pattern of 800-1,200 kcal/d (Level of evidence C, strong recommendation; 94.5% agreement).

The Doctor Referral of Overweight People to Low Energy Total Diet Replacement Treatment (DROPLET) trial used a meal replacement providing 810 kcal/d as the sole source of energy intake, which was changed to CRD after eight weeks of intervention and continued to the 12th month. At the end of the study, 138 severely obese individuals lost an average of 10.7 kg and showed significant improvements in biomarkers for cardiovascular and metabolic risks. Severely obese individuals may calculate energy requirements for weight maintenance as estimated body weight × 22 kcal ± 20%, based on which a decrease in daily energy intake by 400-600 kcal may be adopted to achieve a weight loss of approximately 0.5 kg/week during the initial stages of weight loss. However, as nonadipose tissue decreases, the body's response to energy changes might be diminished, requiring increased energy expenditure or further restriction of energy intake to lose further weight.[240,241]

Question 50: Can very-low-calorie meal replacements be used in severely obese individuals?

Very-low-calorie meal replacements (<800 kcal/d) may be chosen as a short-term nutritional intervention option for people with severe obesity under regular monitoring and close follow-up by an MDT (Level of evidence B, weak recommendation; 91.6% agreement).

Nineteen RCT studies adopted very-low-calorie meal replacements of ≤800 kcal/d (400-800 kcal/d) as part of the intervention for severely obese individuals for 4 to 12 weeks, with a total follow-up period of 12 months. Compared to participants with other interventions (18 RCTs) or control participants with routine care (1 RCT), participants in the very-low-calorie meal replacement group lost more weight and had greater decreases in diastolic blood pressure, HbA1c and fasting glucose concentrations, and osteoarthritis symptoms. However, no significant differences between groups were observed at 24 months. The common adverse effects in the very-low-calorie meal replacement group included constipation, flatulence, dizziness, vulnerability to flu, headache, fatigue, and muscle weakness.[123,242-258]

Periconceptional management and medical nutrition therapy for weight loss

The overweight and obesity rates among Chinese women of childbearing age have reached 25.4% and 9.2%, respectively. Prepregnancy obesity increases the risk of early and recurrent miscarriages.[259,260] Obesity before and during pregnancy increases the risk of pregnancy complications and adverse pregnancy outcomes.[122] Lifestyle interventions for overweight/obese pregnant women may improve pregnancy weight gain and pregnancy outcomes.[261] Appropriate dietary interventions may reduce pregnancy weight gain.[262,263] However, the improvements in pregnancy outcomes are inconsistent.[264-267]

Question 51: Can integrated interventions improve weight gain during pregnancy in overweight/obese pregnant women?

Lifestyle interventions including dietary interventions (personalized dietary guidance, low-GI diet, DASH diet, etc.) for overweight/obese pregnant women may improve weight gain during pregnancy (Level of evidence B, strong recommendation; 96.6% agreement).

A meta-analysis included four RCTs with 537 obese pregnant women and showed that intensive dietary interventions were more effective in reducing weight gain during pregnancy.[262] Another meta-analysis included 21 RCTs involving overweight or obese pregnant women with healthy dietary interventions in 719 people and showed a significant reduction in pregnancy weight gain.[263] A multiethnic, multicenter RCT of 1,555 obese pregnant women evaluated an intervention with a low-GI diet in combination with physical activity. The results showed a significant reduction in pregnancy weight gain in the intervention group.[264] Vesco et al[268] explored the effects of a DASH diet on the improvement of pregnancy weight gain and pregnancy outcomes in obese pregnant women, and the results showed that pregnant women in the intervention group gained less weight during pregnancy compared to the control group.

Question 52: Can vitamin D supplementation during pregnancy in overweight/obese women improve pregnancy outcomes?

Overweight/obese women are at high risk of vitamin D deficiency during pregnancy, and testing during pregnancy should be extended. High-dose vitamin D supplementation may improve pregnancy outcomes (Level of evidence D, weak recommendation; 94.9% agreement).

A higher prepregnancy BMI may increase the risk of vitamin D deficiency, with a 2.0-fold and 2.1-fold increase in the incidence of maternal and neonatal vitamin D deficiency, respectively, when the BMI increases from 22 kg/m^2 to 34 kg/m^2. A prospective cohort study found that prophylactic high-dose vitamin D supplementation in obese women was effective in inhibiting weight gain, increasing vitamin D concentrations, as well as improving pregnancy and neonatal outcomes, without affecting the metabolism of the endocrine system.[269]

Childhood and adolescent obesity and medical nutrition therapy for weight loss

Childhood obesity may present with abnormalities in the cardiovascular system, endocrine system, digestive system, neurological system, skeletal system, pulmonary system, skin, and mental health. Continuous dietary management and exercise are the long-term management methods of obesity in children. Nutritional therapy is the preferred first-line treatment for obese children and adolescents, but the management modalities differ from those of adults in that the calorie restriction must also ensure normal growth and development of children and adolescents. The ratios of the three major nutrients in the weight loss diets for obese children and adolescents are recommended according to the Chinese Dietary Guidelines (2016), which recommend a dietary structure with 50-60% of carbohydrate, 20-30% of fat, and 15-25% of protein, with the involvement of an MDT and the extensive participation of families, schools, and communities.

Question 53: What nutritional approaches are appropriate for overweight/obese children and adolescents to lose weight?

CRD is beneficial for weight control in overweight/obese children and adolescents. Calorie supply should be reduced while ensuring energy requirements for normal growth. However, a very-low-calorie diet is not recommended (Level of evidence B, strong recommendation; 95.4% agreement).

Zhang et al[270] conducted a short-term dietary intervention among obese children aged 8-14 years, with reduced energy supply, fiber-rich foods, avoidance of high-calorie and high-fat foods, and slight control of staple foods while ensuring energy required for growth. After three weeks of intervention, significant reductions were observed in body weight, waist circumference, hip circumference, BMI, and body fat content of obese children compared to pre-intervention levels. Andela et al[271] examined 24 clinical studies and found that 3-20 weeks of continuous intervention with a very-low-calorie diet in obese children aged 5-18 years resulted in significant weight loss compared to controls. However, the safety of very-low-calorie diets should still be followed up over time, with comprehensive monitoring of all adverse events.

Question 54: Are vitamin D and calcium supplements required for overweight/obese children and adolescents during weight loss?

Overweight/obese children and adolescents have high rates of vitamin D deficiency and may require doubling supplements during weight loss to maintain the serum vitamin D at normal levels (Level of evidence C, weak recommendation; 94.9% agreement).

A study enrolling 18 obese and 18 nonobese adolescents showed that 25(OH)D_3 deficiency rates were 78% and 61%, respectively. The administration of 2,000 U of vitamin D3 per day for 12 weeks showed an increase in 25(OH)D_3 concentrations and a significant decrease in deficiency rates among the obese adolescents.[272] Nappo et al[273] conducted a six-year follow-up on 6,696 children, and the results showed lower increases in the z-scores of BMI, waist circumference, and fat mass index among boys with higher baseline calcium intake. However, only lower increases in the z-score of the waist circumference were observed in girls.

Question 55: How should overweight/obese children and adolescents exercise to lose weight more efficiently?

Overweight/obese children and adolescents should have at least 60 min of moderate-to-vigorous physical activity per day (Level of evidence B, strong recommendation; 97.2% agreement)

The Global Recommendations on Physical Activity for Health by the World Health Organization (WHO) recommends that children and adolescents aged 5-17 years should have at least 60 min of moderate-to-vigorous physical activity per day to maintain health and growth, and more than 60 min of physical activity for additional health benefits. Meanwhile, vigorous physical activity at least three times per week should be performed, including activities that strengthen muscles and bones.[274] The meta-analysis by Stoner et al.[275] included 20 studies with 1,091 overweight/obese adolescents, and the results showed that exercise interventions reduced body weight, and there was a positive linear relationship between the amount of exercise and the amount of weight loss.

Question 56: Does family-centered treatment play an important role in the treatment of overweight/obesity in children and adolescents?

A comprehensive family-centered approach to weight loss has a positive impact on the improvement of health and social cognition for overweight/obese children and adolescents (Level of evidence B, strong recommendation; 96.2% agreement).

The prospective RCT by Sweeney et al[276] included 82 African American overweight/obese adolescents aged 11-16 years in an eight-week face-to-face group intervention and an eight-week online intervention group with a curriculum that included self-monitoring strategies, positive communication, goal setting, improved behaviors, etc. The results indicated that the comprehensive weight loss approach had a positive impact on the improvement of cognition and social well-being of African American adolescents. In terms of social outcomes, the adolescents benefited more from positive communication with their parents.

Question 57: How to maintain the weight loss outcomes in overweight/obese children and adolescents?

Adherence to long-term follow-up after weight loss, including face-to-face consultations or telephone calls, has a positive impact on maintaining weight loss outcomes, promoting physical and mental health, and improving the quality of life in overweight/obese children and adolescents (Level of evidence B, strong recommendation; 96.2% agreement).

The 11-year follow-up study by Mameli et al.[277] in 864 children and adolescents showed that weight loss outcomes were better for those who adhered to the outpatient follow-up visits. Nguyen et al.[278] assessed the effect of additional treatment contact on weight loss maintenance and showed that the use of phone, text, and email communication every two weeks had a positive effect on maintaining weight loss with a significant reduction in BMI z-scores.

Older adults with obesity and medical nutrition therapy for weight loss

Sarcopenic obesity in the elderly is defined as a common syndrome of the elderly characterized by age-related decreases in skeletal muscle strength, mass, and function, as well as obesity.[279] In China, the prevalence of sarcopenic obesity in the elderly is 4-20%.[280] Older adults with sarcopenic obesity were more likely to experience physical disability and balance disorders, and they had an increased risk of falls compared to those with obesity or sarcopenia alone.[281] A meta-analysis that included 12 prospective studies with 35,287 older adults showed that those with sarcopenic obesity had a 24% increased risk of all-cause mortality.[282]

Question 58: Should dietary protein intake be increased in elderly adults with sarcopenic obesity?

Dietary protein intake should be increased as appropriate for the elderly with sarcopenic obesity to ensure a dietary protein intake of 1.0-1.5 g/kg/d while limiting calories. Very-low-calorie diets are not recommended (Level of evidence C, strong recommendation; 95.4% agreement). Dietary protein should be distributed evenly across meals, with at least 25-30 g of protein per meal. Both the quantity and quality of dietary protein should be ensured to stimulate muscle protein synthesis (Level of evidence C, weak recommendation; 94.9% agreement).

The systematic analysis by Kim et al.[283] evaluated the effects of protein intake in a low-calorie diet on body mass, skeletal muscle mass, and fat mass in older adults, and the results showed that older adults consuming a diet with higher protein concentrations (≥1.0 g/kg/d) retained more skeletal muscle and lost more fat during weight loss. Beavers et al.[284] conducted a six-month weight loss program with an HPD in 96 obese older adults, and the results showed that the program was effective in reducing total body weight and fat mass in older adults with obesity and helped to maintain lean body mass and mobility. However, very-low-calorie diets should be avoided in older adults, as they may downregulate skeletal muscle protein synthesis and accelerate protein catabolism, which may lead to reduced skeletal muscle mass and strength, as well as increased risks for fluid and electrolyte imbalances in older adults.[285]

Studies have shown that muscle protein synthesis became blunted when the elderly consumed less than 20 g of protein per meal, while 25-30 g of protein per meal maximized the stimulation of muscle protein synthesis in the elderly.[286,287]

Question 59: Is β-hydroxy-β-methyl-butyrate (HMB) supplementation required in older adults with sarcopenic obesity? Is omega-3 PUFA supplementation required?

Moderate supplementation with HMB combined with appropriate exercise may improve skeletal muscle mass and strength as well as maintain the skeletal muscle function in older adults (Level of evidence B, weak recommendation; 94.5% agreement). Older adults with sarcopenic obesity may be moderately supplemented with omega-3 PUFA (Level of evidence C, weak recommendation; 92.8% agreement).

HMB, which promotes skeletal muscle protein synthesis, inhibits the degradation of skeletal muscle proteins, and reduces inflammatory responses, can be used as a nutritional supplement to improve muscle protein synthesis and reduce the progression of sarcopenia in healthy or frail older adults.[288] One study showed that HMB supplementation at 2-3 g/day in elderly nursing home residents significantly increased skeletal muscle mass after one year. Zhang et al[289] included 11 RCT studies with 617 individuals and demonstrated a significant reduction in waist circumference among those supplemented with omega-3 PUFA. Dupont et al[290] pointed out that supplementation with omega-3 PUFA was beneficial for older adults with sarcopenia and may enhance the effects of exercise or protein supplementation.

Question 60: Is vitamin D supplementation required for elderly people with sarcopenic obesity?

Vitamin D supplementation of 800-1,000 IU/d is recommended (Level of evidence B, strong recommendation; 96.6% agreement).

The cross-sectional study in community-dwelling older adults by Morley et al.[291] found that vitamin D concentrations were directly related to physical mobility, particularly in older adults with 25(OH)D_3 concentrations below 75 nmol/L. In the National Health and Nutrition Examination Survey (NHANES) in the USA, over 30% of elderly aged 70 years and higher had vitamin D concentrations below 50 nmol/L.[292] Scott et al[293] showed that the administration of 800-1,000 U of vitamin D per day improved muscle indicators in older adults.

Question 61: Is calorie-restricted HPD available for weight loss among older adults with obesity?

The short-term application of calorie-restricted HPD is effective in reducing the total body weight and fat mass, as well as improving metabolic syndrome-related indicators in older adults (Level of evidence B, weak recommendation; 94.1% agreement).

Porter Starr et al[294] administered a low-calorie diet (a decrease by 500 kcal) in older adults with a BMI $\geq$ 30 kg/m^2 and a simple fitness test score of 4 to 10. The protein intake was 0.8

g/kg/d in the control group and 1.2 g/kg/d in the test group. After six months of intervention, both groups showed significant decreases in body weight, but the levels of inflammation markers of the elderly in the test group improved, especially for adiponectin, leptin, hypersensitive C-reactive protein, and intercellular adhesion molecule-1. Weaver et al[295] conducted a six-month RCT in which obese older adults were randomized to a stable weight group and a weight loss group. A low-calorie HPD with complete nutrition was adopted in the weight loss group, and participants were encouraged to maintain basic dietary and physical activity habits. The results showed improvements in the bone density of the hip and spine in the weight loss group compared to the stable weight group.

Question 62: For obese older adults, is it possible to lose weight using calorie-restricted meal replacement?

The short-term use of calorie-restricted meal replacement may reduce body weight and fat in older adults with obesity. However, adequate nutrient intake should be guaranteed (Level of evidence A, strong recommendation; 94.1% agreement).

In a six-month pretrial, 28 volunteers were randomly assigned to either the calorie-restricted balanced diet group or the intensive low-calorie meal replacement group. Both groups of volunteers had similar behavioral interventions and exercise prescriptions, and the results showed that severely obese older adults in the intensive low-calorie meal replacement group lost more weight and fat mass with a lower incidence of adverse events.[296] In an eight-week study of CRDs, 12 older adults with obesity were randomized into two groups, with one group adopting a whey protein + essential amino acid meal replacement and the other receiving a regular meal replacement. The results showed that the use of the whey protein + essential amino acid meal replacement accelerated the prioritized decrease in adipose tissue and preserved the lean body tissue in older adults.[297]

Polycystic ovary syndrome and medical nutrition therapy for weight loss

PCOS is the most common endocrine disorder in women that affects 8-13% of women of childbearing age, with more than 50% of patients being also affected by obesity.[296] Insulin resistance and compensatory hyperinsulinemia are present in 95% of overweight women with PCOS. Studies have shown that lifestyle interventions may improve indicators including free androgen index, body weight, BMI, and insulin concentrations in overweight/obese women with PCOS.[298,299]

Question 63: What are the nutritional weight loss goals for overweight/obese women with PCOS?

Overweight/obese women with PCOS should lose 5-10% of their initial body weight within six months (Level of evidence C, weak recommendation; 95.4% agreement).

Fourteen overweight/obese women with PCOS lost 5-10% of their body weight on a low-calorie diet of 1,000-1,500 kcal/d, through which they resumed normal menstrual cycles with ovulation, and had significant decreases in the waist-to-hip ratio, as well as plasma androgen and serum luteinizing hormone concentrations. Decreases in plasma androgen concentrations and waist-to-hip ratio were positively associated with improvements in insulin concentrations.[300] The prospective study by Crosignani et al[301] assessed the effects of weight loss on anthropometric measures and ovarian morphology in women with anovulatory PCOS and a BMI >25 kg/m^2. A diet of 1,200 kcal/d was administered supplemented with physical activity for six months. The results showed that 76% of the patients lost at least 5% of their body weight, with decreases in ovarian volume and a significant reduction in the number of microcysts per ovary. Of the 27 patients with oligomenorrhea or amenorrhea, 18 patients resumed regular menstrual cycles, and 15 patients ovulated spontaneously.

Question 64: What dietary pattern should overweight/obese women with PCOS adopt to lose weight? Is a low-carbohydrate diet suitable for overweight/obese women with PCOS?

All overweight/obese women with PCOS should reduce the total dietary calorie intake to lose weight with healthy food choices (Level of evidence C, strong recommendation; 95.8% agreement). Women with PCOS and overweight/obesity may be placed on a short-term low-carbohydrate diet for weight loss under the joint supervision of a gynecologist and nutritionist, with regular monitoring of ketone bodies and hormone concentrations during weight loss (Level of evidence B, weak recommendation; 94.9% agreement).

The systematic review by Moran et al[302] included five RCTs with 137 overweight/obese women who had PCOS. The results showed that weight loss improved metabolic, reproductive, and psychological health in women with PCOS regardless of dietary patterns, but no dietary structure was more beneficial than restricting calorie intake. The systematic review by Lie Fong et al[303] included 11 RCT studies with more than 24 weeks of follow-up. The results showed no differences in weight loss between healthy diets based on calorie restriction, HPD, vegetarian diets, low-GI diets, and low-fat diets. The 2018 International Evidence-Based Guidelines for the Assessment and Management of PCOS state that in women with PCOS, no or only limited evidence exists regarding the preferential dietary type. A variety of balanced diets with reduced calorie intake are recommended to lose weight in overweight/obese women with PCOS.[304]

A meta-analysis that included eight RCTs with 327 individuals found that participants in the LCD group had more significant reductions in BMI, HOMA-IR, as well as TC and LDL-C concentrations. In particular, participants who received more than four weeks of intervention had significant increases in follicle-stimulating hormone and sex hormone-binding globulin concentrations, as well as significant decreases in androgen concentrations. Moreover, the improvement in hormone concentrations was significantly higher in the low-fat LCD group compared to the high-fat LCD group.[305]

Diabetes mellitus and medical nutrition therapy for weight loss

It is estimated that in 2019, 116 million people with diabetes lived in China, ranking it first in the world.[306] The prevalence of diabetes in adults was as high as 11.2%, and overweight/obese patients with T2DM accounted for approximately 58.3% of all patients with diabetes mellitus.[307,308] MNT may help overweight/obese patients with diabetes to achieve and maintain their target weight and may prevent or alleviate diabetes symptoms.

Question 65: What weight loss goals should be set for overweight/obese patients with diabetes mellitus? What dietary patterns are more effective in helping overweight/obese patients with diabetes/prediabetes to lose weight?

Overweight/obese patients with diabetes mellitus should set the initial weight loss goal to 5-10% of body weight (Level of evidence A, strong recommendation; 95.4% agreement). MNT for the treatment of diabetes encourages balanced diets with calorie restrictions (Level of evidence A, strong recommendation; 96.2% agreement). Multiple dietary patterns should be adopted with an emphasis on food diversity. Attention should be paid to the applicable population and adverse effects of individualized diets (Level of evidence C, strong recommendation; 97.4% agreement).

The Guideline for the Prevention and Treatment of Type 2 Diabetes Mellitus in China (2020 Edition) recommends a weight loss goal of 5-10% of body weight for overweight/obese patients with T2DM.[308] Multiple studies suggested that interventions with a weight loss >5% of body weight may help control HbA1c and blood lipid concentrations, as well as blood pressure, in patients with diabetes mellitus.[309-311]

CRD, a cornerstone of MNT, recommends calculating calories based on 25-30 kcal/kg/d and individualized dietary patterns but does not recommend the long-term use of very-low-calorie diets (<800 kcal/d). The Look AHEAD (Action for Health in Diabetes) study included 5,145 overweight/obese patients with T2DM in 16 study centers in the USA to receive an intensive personal behavior intervention in which dietary calorie intake was decreased by 500-750 kcal/d. The results showed significant weight decreases in patients of the intervention group compared to those of the control group.[312] In the DiRECT study, patients in the intervention group first received a low-calorie diet for three to five months, followed by a gradual return to a normal diet over six to eight weeks. By 12 months of follow-up, 24% of patients in the intervention group had lost 15 kg of weight, with a mean weight loss of 10 kg. In addition, diabetes was in remission in 46% of these patients.[16] Current evidence does not yet support a particular dietary pattern, and diets should be designed with a variety of foods, with preferences in whole grains with increased intake of nonstarchy vegetables. Dietary patterns with a single energy-producing nutrient ratio are not recommended for patients with diabetes mellitus. A variety of dietary patterns may be recommended to help with weight loss in patients with diabetes/prediabetes. However, this should be done under professional guidance in conjunction with the patient's/population's metabolic goals and personal preferences, while monitoring for changes in blood lipids, renal function, and visceral protein.

Metabolic associated fatty liver disease and medical nutrition therapy for weight loss

Metabolic associated fatty liver disease (MAFLD) is one of the major liver diseases that threaten the health of Chinese people, with approximately 240 million patients with MAFLD in China, of which approximately 30 million are affected by steatohepatitis.[313] Overweight/obesity is one of the most common risk factors for MAFLD,[314] and MAFLD may also be improved to varying degrees after weight loss through lifestyle improvement or bariatric surgery.[315,316]

Question 66: Is restriction of alcohol consumption required during weight loss for the treatment of MAFLD?

Patients with MAFLD should abstain from alcohol use during weight loss (Level of evidence A, strong recommendation; 97.9% agreement).

The prospective study by Younossi et al[317] included 4,246 patients with MAFLD with a mean follow-up of 20 years to analyze the survival-related factors of patients. Multifactorial analysis results showed that excessive alcohol consumption was a high-risk factor for death. Ajmera et al[318] reported that 59% of the 285 MAFLD patients were modest alcohol users and 41% were abstainers. Lifestyle adjustments were adopted, but no drug treatment was administered. After a mean follow-up of 47 months, the comparison of liver biopsies showed that the improvement of hepatic steatosis and fibrosis in abstainers was significantly better than that in patients with moderate consumption of alcohol and that the glutamic transaminase concentrations and MAFLD activity scores of abstainers were significantly lower than those in patients with moderate consumption of alcohol. Moreover, the improvement rate of nonalcoholic steatohepatitis was higher in abstaining patients than in patients with moderate alcohol consumption.

Question 67: What dietary pattern is more helpful for weight loss in patients with MAFLD?

Patients with MAFLD may choose diets such as the Mediterranean diet or IER as appropriate based on individual conditions during weight loss to improve MAFLD prognosis while controlling calorie intake (Level of evidence B, weak recommendation; 96.2% agreement).

The results of the systematic review by Saeed et al.[319] suggested that the Mediterranean diet, IER, and low-fat diets all resulted in varying degrees of improvement in body weight and hepatic steatosis. The *2020 edition of the Asian Pacific Association for the Study of the Liver Clinical Guidelines on MAFLD* recommends that the core of dietary control for patients with MAFLD is to achieve a negative balance between energy intake and expenditure and that dietary plans may be chosen as appropriate according to individual conditions.[320]

Gout and medical nutrition therapy for weight loss

Hyperuricemia is defined as a fasting blood uric acid concentration of >420 μmol/L on two different days on a normal purine diet.[321] In many large epidemiological studies, high BMI has been identified as a risk factor for gout.[322] Obesity promotes insulin resistance, which in turn reduces renal excretion of uric acid, thereby leading to hyperuricemia.3233Weight loss in obese patients may lower uric acid concentrations and reduce the incidence of gouty arthritis.[324, 325]

Question 68: What dietary options are appropriate for obese patients with gout?

Obese patients with gout may choose the Mediterranean diet or DASH diet to not only lose weight but also to reduce the risk of gout (Level of evidence C, strong recommendation; 96.6% agreement).

Studies have found that the Mediterranean diet may not only help obese people lose weight, decrease BMI, and reduce waist circumference,[326] but also lower blood uric acid concentrations[327,328] and improve the metabolic syndrome.[329] The Mediterranean diet is effective in reducing blood uric acid concentrations in patients with hyperuricemia, especially in the first month after the intervention.[330] For men with a BMI <30 kg/m^2, strict adherence to the DASH diet with no alcohol consumption may significantly reduce the risk of gout onset.[331]

SUMMARY

Overweight and obesity are both scientific and social issues. New clinical evidence regarding MNT for weight loss may be discovered, and a standardized process should be followed to provide a more scientific basis for the “healthy weight” target proposed in the Healthy China 2030 plan with the goal of preventing obesity-related complications and improving the health of obese individuals.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors declare no conflict of interest, financial or otherwise.

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Table 1. Grading system according to the GRADE framework

Level of evidence	Specific description
High (A)	High confidence that the estimated effect is close to the true effect and that further research is unlikely to change the confidence level of the effect
Moderate (B)	Moderate confidence in the estimated effect in that the effect may be close to the true effect, but there is still the possibility that the two are different. Further research may change the confidence in the effect
Low (C)	Limited confidence in the estimated effect, which may differ substantially from the true effect. Further research is highly likely to change the confidence in the estimated effect
Very low (D)	Little confidence in the estimated effect; the estimated effect is likely to be completely different from the true effect. All estimates of the effect are highly uncertain

Table 2. Strength of recommendations according to the GRADE framework

Strength of recommendation	Specific description
Strong recommendation	The evidence clearly shows that the intervention does more good than harm or more harm than good
Weak recommendation	Uncertain about the benefits and drawbacks of the intervention or evidence shows comparable benefits and drawbacks regardless of evidence quality