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Low calorie diet in diabetes mellitus type 2

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There is substantial evidence indicating that weight loss is highly effective in managing glycemic control and cardiometabolic health in type 2 diabetes (DM2). Therefore, medical nutrition therapy (MNT) and comprehensive diabetes self-management education and support (DSMES) that include an overall healthy eating plan in a format that results in an energy deficit, as well as a collaborative effort to achieve weight loss in people with type 2 diabetes who are overweight/obese, are recommended. In DM2, 5% weight loss (WL) is recommended to achieve clinical benefit and the benefits are progressive. The goal for optimal outcomes (e.g. diabetes remission) is 15% or more WL when needed and can be feasibly and safely accomplished. Eating plans that create an energy deficit and are customized to fit the person's preferences and resources can help with long-term sustainment and are the cornerstone of weight loss therapy.

15% or more WL is achieved with low calorie diets. The term "low calorie diets" includes low calorie diets (LCDs), very low calorie diets (VLCDs) and intermittent fasting (IF). The key points of these diets are that they vary depending on the type and amount of carbohydrate, protein and fat consumed to meet the daily caloric intake goals. Diets of equal caloric intake result in similar weight loss regardless of the macronutrient content. Also, the metabolic status of the patient based on lipid profiles, renal and liver function is the main determinant for the macronutrient composition of the diet.

LCDs are defined as diets with caloric deficit 500-800 Kcal per day from energy demand (ED). They usually use conventional food but meal replacements can be used as well.

VLCDs are defined as diets limiting energy intake to 450–800 kcal per day, while providing at least 50 g of high-quality protein and amino acids, essential fatty acids and daily requirements of trace elements, vitamins and minerals. They are recommended only in the obese [body mass index (BMI) $\geq$30 kg/m^2] or in individuals with BMI >27 kg/m^2 plus one or more co-morbidities. Generally, they involve an intensive phase (three meal replacements) usually lasting 8-16 weeks. In addition, two cups of salad or low-starch vegetables are eaten to provide fiber to lessen hunger and reduce constipation. A tablespoon of oil or butter and 2 liters of water or calorie free beverages are also consumed to prevent gallstones. Subsequently,

reintroduction of conventional food (12-14 weeks) in the diet and then followed by a weight stabilization program.

IF has recently gained popularity as a mean of reducing body weight and improving metabolic status. An important feature of IF schedules is that all meals are consumed during a strictly defined window of time and followed by fasting. Such fasting is achieved by ingesting little to no food or caloric drinks for periods that typically range from 16 to 24 hours, e.g., as the prolongation of the physiological overnight fast. Thus, the IF method does not describe which nutrient types are allowed, assuming only that the person eats a balanced diet and conforms to the rules of healthy eating. Because the time span of the "feeding window" is short, the overall calorie intake is lower than if the food intake time was unlimited. Different regimens of IF have been employed in daily practice and clinical trials. The most popular is alternate day fasting (ADF), which involves "fast days" alternating with "feed days" (ad libitum food consumption), typically carried out for weeks to months.

There are some absolute contraindications to the use of very-low-calorie diets such as, BMI <25 kg/m^2, pregnancy/lactation, clinical eating disorder, major psychiatric illness, severe systemic or organ disease, e.g.: recent myocardial infarct/angina/stroke, major dysrhythmia, severe renal/hepatic disease, malignancy, wasting disorders, e.g. Cushing's syndrome. Thus, there are some relative contraindications such as, age >65 years, child <16-18 years, type 1 DM, gout, cholelithiasis.

Effects of VLCDs and IF on plasma glucose levels occur rapidly, a decrease in mean glucose levels is seen within days and reaching near nadir after 1-2 weeks. Calorie restriction leads to glycogen depletion in muscle and liver. Thus, restriction of carbohydrate leads to lipolysis and the formation of ketone bodies by the liver. Together, these lead to reductions in hepatic glucose output via inhibition of gluconeogenesis and reduced glycogenolysis. High protein stimulates insulin secretion and increases satiety. Circulating ketone bodies probably contribute to tolerability of the diet by suppressing appetite in the hypothalamus. Weight loss and diminution of fat depots in the liver, muscle and peri-visceral space lead to reductions in insulin resistance. Improved insulin sensitivity, dynamic insulin secretion and reduced hepatic glucose output lead to reductions in blood glucose levels.

Recent studies showed that in the first 10 years of type 2 diabetes, negative calorie balance rapidly normalizes liver fat content, hepatic glucose production and fasting plasma glucose; and if the negative calorie balance is sustained, intra-pancreatic fat content and insulin secretion also normalize and may lead to diabetes remission.

The paucity of controlled, large-scale research trials makes it difficult to prescribe LCDs or IF as reliable, routine methods for safe and successful, stable weight loss. VLCDs are considered safe and effective when used by appropriately selected individuals under careful medical supervision.

Weight regain after dietary interventions is a common occurrence and further exploration of weight loss and weight maintenance could also lead to identification of the best active ingredients for optimum weight loss and its maintenance in the future.