Chapter 9

Medical Nutrition Therapy for Special Groups with Diabetes Mellitus

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.70815

Abstract

The prevalence of diabetes mellitus (DM) is increasing worldwide. Medical nutrition therapy increases the success of diabetes treatment and provides an appropriate glycemic control that decreases diabetes complications. The requirement of energy and nutritional elements may differ according to specific conditions including age, the presence of pregnancy, or comorbidities. Therefore, these specific conditions should be taken into account in the planning of medical nutrition therapy. Ensuring continuity of children and young growth and development, providing requirements based on comorbidities and physiological alterations in older adults, and protection of fetal development and maternal glycemic and nutrient balance in pregnancy should be aimed in the determination of energy and nutritional elements requirements. Here, we will discuss the medical nutrition therapy in special groups with diabetes mellitus.

Keywords: diabetes mellitus, pregnancy, youth, elderly, nutrition

1. Diet in patients with gestational diabetes

1.1. Introduction

Gestational diabetes mellitus (GDM) is described as any degree of carbohydrate intolerance first recognized during pregnancy [1]. GDM affects 4–8% of pregnant women in developed countries [2]. GDM is associated with an increased risk of adverse maternal and fetal outcomes, hence providing good glycemic control to substantially improve outcome [3].

Alterations in the secretion of growth hormone and cortisol and increase in human placental lactogen and insulinase levels are the mechanisms of insulin resistance during pregnancy.

Additionally, increased estrogen and progesterone make a contribution to the impaired glucose tolerance. The increase in adipose tissue, less exercise, and increased caloric intake during pregnancy are also other contributors [4].

1.2. Diagnosis

Diabetes diagnosed during the first trimester of pregnancy should be described as type 2 diabetes mellitus. GDM is diabetes diagnosed after the first trimester of pregnancy that is not clearly either type 1 or type 2 DM [5].

There are two strategies in diagnosing of GDM [5].

"One step" approach:

A 2-h 75-g oral glucose tolerance test (OGTT) is performed at 24–28 weeks of gestation in women without an overt diabetes diagnosis. Glucose concentrations after fasting and 1 and 2 h after glucose administration <92 mg/dL (5.1 mmol/L), <180 mg/dL (10.0 mmol/L), and <153 mg/dL (8.5 mmol/L), respectively, were accepted as normal; if the glucose concentration is over than the normal at any point, the patient is diagnosed with GDM.

"Two-step" approach:

Step 1: Perform a 50-gr OGTT (nonfasting), measure plasma glucose at 1 h, at 24–28 weeks of gestation in women without an overt diabetes diagnosis. If the plasma glucose concentration is higher than 140 mg/dL (7.8 mmol/L) at 1 h after the load, proceed to a 100-gr OGTT.

Step 2: Perform a 100-g OGTT when the patient is fasting. If the glucose concentration is more than the normal at least two of the following four plasma glucose levels, the patient diagnosed with GDM.

Carpenter/Coustan	or National Diabetes Data Group (NDDG)
Fasting 95 mg/dL (5.3 mmol/L)	105 mg/dL (5.8 mmol/L)
1 h 180 mg/dL (10.0 mmol/L)	190 mg/dL (10.6 mmol/L)
2 h 155 mg/dL (8.6 mmol/L)	165 mg/dL (9.2 mmol/L)
3 h 140 mg/dL (7.8 mmol/L)	145 mg/dL (8.0 mmol/L)

Although one-way strategy was shown to be cost-effective [6] and may be the preferred approach, data comparing population-wide outcomes with two strategies are contradictory [7, 8]. Longer term outcome studies are currently on the way.

1.3. Metabolic changes during pregnancy

Women with GDM do not have an essential β-cell reserve to produce adequate insulin to overcome the insülin resistance of pregnancy, and all women with GDM have a degree of impaired function of β-cell [9]. Basal glucose and insulin levels are similar to nongravid

http://dx.doi.org/10.5772/intechopen.70815

values in early pregnancy [10]. Basal hepatic glucose production is also similar to the 12–14th week of pregnancy. Postprandial glucose concentrations are significantly elevated, and the glucose peak is prolonged. Basal glucose levels decrease by 10–15 mg/dL (0.56–0.83 mmol/L), insulin levels increased by two fold, and peak of glucose is prolonged at the third trimester [11]. Increased glucose production is seen by the increase in maternal body weight; however, glucose production per kilogram body weight remains unchanged during gestation [12].

Plasma triacylglycerol, fatty acid, cholesterol, and phospholipid levels are altered as a result of changes in hepatic and adipose metabolism [13]. Their levels decrease at the early weeks of pregnancy; however, these levels steadily increase during pregnancy. The increase in estrogen levels and insulin resistance are potential mechanisms of hypertriglyceridemia in pregnancy [14]. Placenta uses cholesterol for steroid synthesis and fatty acids for placental oxidation and membrane formation [15]. Hepatic lipoprotein lipase decreases postprandially; however, it increases during fasting, which increases production of fatty acids and ketones for the fetus to compensate low glucose supply [14]. GDM induces a state of dyslipidemia consistent with insulin resistance. During pregnancy, women with GDM do have higher serum triacylglycerol concentrations, but lower LDL-cholesterol concentrations decrease during pregnancy; however, total cholesterol, HDL cholesterol, and apolipoprotein concentrations are not changed [14, 16].

1.4. Management of Diabetes in pregnancy

Diagnosing women with GDM is extremely significant for close follow-up of the fetus throughout gestation and to identify women with risk of type 2 diabetes occurrence [17]. The main target of the medical treatment in GDM is to provide a good glycemic control, particularly for postprandial concentrations [2]. Treatment of gestational diabetes reduces serious perinatal morbidity and may also improve the woman's health related [18]. Serious perinatal morbidity is decreased, and maternal health-related quality of life is improved by the treatment of GDM. Although glucose goals throughout gestation are very strict, hypoglycemia should be avoided. Preconceptional target for HbA1c is <6.5% to decrease congenital anomalies [19].

American Diabetes Association recommendation for glucose concentration goals in women with GDM:

- Fasting ≤95 mg/dL (5.3 mmol/L) and either
- One-hour postprandial ≤140 mg/dL (7.8 mmol/L) or
- Two-hour postprandial ≤120 mg/dL (6.7 mmol/L)

Glucose concentration goals in pregnant women with pre-existing type 1 or type 2 diabetes, if it can be achieved without excessive hypoglycemia:

- Premeal, bedtime, and overnight glucose 60–99 mg/dL (3.3–5.4 mmol/L)
- Peak postprandial glucose 100–129 mg/dL (5.4–7.1 mmol/L)
- A1C <6.0% [20]

GDM patients should have at least four blood glucose measurement daily (fasting and 1 h after the first bite of each meal) to monitor hyperglycemia that is known to increase the risk of adverse maternal and fetal outcomes. One-hour postprandial glucose monitoring provides a better glycemic control and fewer cases of large-for-gestational age infants compared to fasting glucose monitoring [21]. Postprandial monitoring provides a better glycemic control and lower risk of preeclampsia [22, 23].

GDM is associated with higher macrosomia risk and birth complications and an increased risk of maternal type 2 diabetes postpartum [3]. Diet, exercise, and lifestyle changes may decrease the risk of GDM [24, 25]. Lifestyle modification alone is sufficient in most of the patients to control GDM [26, 27]. However, early initiation of pharmacologic therapy might be needed when lifestyle modifications are insufficient for glycemic control.

Insulin is the recommended first-line agent in the treatment of GDM. Although randomized controlled trials demonstrated the efficacy and short-term safety of metformin [28, 29] and glyburide [30], long-term safety trials are still lacking for any oral drugs [31].

1.5. Medical nutritional therapy

Prevention of diabetes, providing good glycemic control in existing diabetes, and decreasing the rate of development of diabetic complications are the primary goals of medical nutrition therapy (MNT). All diabetic patients should have an individualized MNT, ideally prepared by a registered dietitian who is knowledgeable and experienced in the management of GDM [32].

Prenatal MNT should provide a meal plan to optimize blood glucose management. Woman's food and eating habits and plasma glucose responses should drive the energy distribution and carbohydrate intake throughout gestation. Since glucose goes through fetus from the mother, the times of food and regular meals and snacks taken are vital to prevent hypoglycemia. Monitoring of plasma glucose and daily food records maintains important information for insulin dosing and meal plan modifications. Sufficient maternal and fetal nutrition, energy taking for adequate weight gain, and all essential vitamin and mineral supplements are primary components of the MNT [26, 32].

The composition of a diabetic diet should be consistent with that for nonpregnant diabetic women and include all the necessary macronutrients and micronutrients in appropriate amounts for growth and development of the fetus.

MNT for GDM should maintain maternal and fetal health with sufficient energy levels providing adequate gestational weight gain, obtainment, continuity of normoglycemia, and lack of ketones. Carbohydrate intake should be divided into three small- to moderate-sized meals and two to four snacks. An evening snack might be recommended in avoiding accelerated ketosis night long [32]. Strict calorie restriction may lead to ketosis as a result of accelerated fat catabolism which is associated with altered psychomotor development [33].

1.6. Energy

Most of the patients with GDM are obese, and additional weight increase during pregnancy leads to adverse pregnancy outcome and long-term risk for development of T2DM. The recommendation of minimal weight gain in obese GDM patients has not been confirmed yet. Weight gain in pregnancy should represent pregestational weight [9].

Although significant caloric restriction in obese GDM patients may cause ketosis, moderate caloric restriction (decrease by 30% of estimated energy requirements) in these patients may provide a good glycemic control without ketonemia and decrease maternal weight gain. The data regarding how such diets have impact on fetal outcomes are lacking [34]. Recommendations for weight gain during pregnancy were shown in **Table 1**.

Adequate energy intake is recommended for proper weight gain. Moderate energy and carbohydrate limitation are recommended, instead of weight loss, for overweight, and obese GDM patients. The primary goals of MNT for GDM are proper weight gain, normoglycemia, and absence of ketosis [34]. The requirement for energy does not rise in the first trimester of gestation. An additional 300 kcal/day is recommended to compensate the increase in maternal blood flow, breast, uterus, adipose tissue, placental growth, fetal growth, and amniotic fluids after the first trimester. Nevertheless, a safe pregnancy is possible with lower energy intake [36]. Quality nutritional intake is required. A number of calories should be calculated according to ideal body weight. The recommendations for daily calorie intake were shown in **Table 2**.

Calorie recommendations may provide normoglycemia in 75–80% of GDM [4]. Reduction in caloric intake by 30–33% would help blood glucose management without increasing ketosis risk in obese women with GDM. Nevertheless, the caloric intake should not be less than 1600–1800 kcal/ day. In cases of calorie reduction, urine should be monitored for ketones. Catabolic metabolism and malnutrition of fetus must be prevented.

The recommended overall dietary ratio: Carbohydrates: 40–50%, protein: 20–25%, and fat: 30–35%. Although restriction of carbohydrate intake to 40–45% of daily energy decreases postprandial glucose, the ratio of carbohydrates should not be lower than 40% [37].

Prepregnancy BMI	**Mothers of singletons**	
	Total weight gain (lb)	**Rate of weight gain in the second and third trimesters (lb/wk)**
Low (BMI < 19.8 kg/m^2)	28–40	~ 1.0 (0.5 kg/wk)
Normal (19.8–26.0 kg/m^2)	25–35	1.0 (0.4 kg/wk)
High (>26.0–29.0 kg/m^2)	15–25	0.66 (0.3 kg/wk)
Obese (≥29.0 kg/m^2)	≥ 15	Not specified

Table 1. Recommendations for weight gain and rate of weight gain during pregnancy [35].

	BMI	Daily calorie intake
Underweight	< 18.5	35–40 kcal/kg
Normal	18.5–24.9	30–34 kcal/kg
Overweight	25.0–29.9	25–29 kcal/kg
Obese	>30	24 kcal/kg

Table 2. The recommendations for daily calorie intake per kg of body weight are.

1.7. Carbohydrate

A specific glucose transporter carries glucose through placenta by a glucose level dependent process. GDM leads to upregulation of these transporters. Glucose transfer is highest during the postprandial period, and decreasing postprandial glucose has a bigger effect on reducing increased fetal growth. Therefore, MNT for GDM should be a focus on decreasing postprandial glucose [9].

The amount and ratio of carbohydrate should be calculated according to clinical outcome measures such as hunger, plasma glucose levels, weight gain, and ketone levels; however, daily carbohydrate should not be less than 175 gr. Total calculated carbohydrate should be divided into three small- to moderate-sized meals and two to four snacks. An evening snack might be added to avoid night long ketosis. Carbohydrate is generally better tolerated at other meals when compared to breakfast [34]. Hence, breakfast cereals with high glycemic index should be switched with more slowly absorbed carbohydrates [9]. A total of 15–30 g of carbohydrates are suggested for breakfast [37]. Small frequent meals with slowly absorbed carbohydrates are very helpful in reducing fasting ketosis which is known to have a negative impact on fetal cognitive development [9].

The glycemic index is a relative measure of a food's carbohydrate content by its impact on postprandial glucose levels. The combination of carbohydrates with high glycemic index and low-cereal-fiber diet could lead to 2.15 fold increase in GDM risk when compared to the reciprocal diet [38]. Decreasing the rate of carbohydrate digestion and absorption and consumption of low glycemic index (LGI) containing foods reduce postprandial blood glucose levels as well as fasting blood glucose [2, 33]. Carbohydrate ratio of >45% in the total energy has a negative impact on glycemic control; however, up to 60% carbohydrate ratio with low-glycemic-index carbohydrates do not have a detrimental effect on glucose tolerance in pregnancy [9]. A diet which is high in carbohydrates of LGI have a positive impact on postprandial glycemic control in nondiabetic pregnants, GDM patients, nonpregnant type 1, and type 2 diabetics. This diet also decreases the required insulin dose in GDM patients [39]. Although an LGI diet has favorable impact on gestational weight gain and maternal glycemic control, it does not decrease the incidence of large for gestational age infants with high risk for fetal macrosomia [40].

High dietary fiber has a positive effect on glycemic control in pregnant women with diabetes, and at least 24-g daily fiber is recommended for all women. Although fructose provides more favorable postprandial glucose when it switches sucrose or starch in the diet, it has a negative

effect on plasma lipid levels. Nevertheless, no studies support the avoidance of consuming fructose found in fruits, vegetables, and other foods [41].

Consuming Food and Drug Administration (FDA) or the European Food Safety Agency (EFSA) verified acceptable daily intake of sugar alcohols and noncaloric sweeteners are considered safe according to limited human studies. Aspartame (with the exception of women suffering from phenylketonuria), acesulfame potassium, sucralose, neotame, advantage, steviol glycosides, and extracts from monk fruit are all FDA-approved noncaloric sweeteners for use during pregnancy. Cyclamates and its salts are currently forbidden in the USA; however, data related to consuming these agents in patients with GDM are lacking [42].

1.8. Protein

Protein intake is very important during pregnancy to compensate the increase in protein synthesis, maintaining maternal tissues and fetal growth, and especially during the third trimester. Low protein intake may have negative effects on weight and length at birth; however, high intake may worsen fetal development [43]. A diet with appropriate protein (0.75 g/kg/day plus an additional 10 g/day) is also necessary for pregnant women. The necessity of nutrient composition during gestation and lactation is not different in women with and without diabetes [36]. Proteins and amino acids in the diet are significant regulators of glucose homeostasis, and a high-protein diet contributes to insulin resistance and increases gluconeogenesis [44]. The amount of protein in the diet should be about 20–25% of the total energy intake, with a minimum of 60–80 g/day according to the German Diabetes Association and German Association for Gynaecology and Obstetrics (DDG-DGGG) [42].

1.9. Fat

Limitation of carbohydrate intake often leads to higher fat intake as protein intake should remain constant at 15–20%. High-fat diet causes an increase in free fatty acid levels which contribute to insulin resistance. Studies in nonhuman primates and human demonstrated that high-fat diet leads to fetal fat accumulation and increase in fetal adipose tissue and contributes to hepatosteatosis, increase in inflammation and oxidative stress, and impairment of glucose uptake in muscles [39].

Limitation of carbohydrate intake increases the ratio of total calories provided from protein and fat to ensure overall energy requirements; however, the data about how the type of dietary fats and carbohydrates affects glycemic control GDM patients are insufficient. Low versus high glycemic foods and monounsaturated fat (MUFAs) versus polyunsaturated fatty acids in the diet have a better impact on glycemic control in nonpregnant patients with T2DM. Gunderson et al. demonstrated that addition of saturated fatty acids to the diet resulted in lower postprandial glucose and insülin response compared to the addition of MUFAs [45]. A recent meta-analysis evaluating the effects of a diet with high MUFAs in T2DM patients found a reduction in fasting blood glucose, postprandial glucose, and whole-day blood glucose and insulin concentrations [46].

2. Medical nutrition therapy in youth diabetics

2.1. Introduction

Type 1 diabetes mellitus (T1DM), the most commonly encountered endocrine disease of childhood, is defined as a decrease and later an absence of pancreatic ß-cell function causing chronic insulin deficiency. Type 1 diabetic youth needs to use insulin to metabolize glucose [47]. The prevalence of T2DM in adolescents increase is accompanied by an increase in T2DM complications such as hypertension, hyperlipidemia, nephropathy, and retinopathy [48].

Involving of adults in the diabetes care of adolescents by professionals is a very important key point. Young children, including school-aged children, are not able to manage their diabetes care, and middle school and high school students need help in managing their diabetes care. Therefore, the education about how all family can be involved in the diabetes care of a diabetic child and adolescent should be ensured [49]. MNT is an essential part of diabetes care in the modern era. MNT is defined as a period of personal guidance to train patients and families related to healthy eating practices to provide a good glycemic control and to prevent or manage comorbidities including overweight, hyperlipidemia, and hypertension. Therefore, MNT is an important component of self-diabetes care [47].

2.2. Diagnosis

The diagnosis of T1DM in children is usually not difficult and needs little or no specialized testing. The most common symptoms and findings of T1DM in children and adolescents are the several-week histories of polyuria, polydipsia, polyphagia, and weight loss with hyperglycemia, glycosuria, ketonemia, and ketonuria. Approximately 30% of children with the T1DM present with diabetic ketoacidosis (DKA). A second confirmatory test should be performed in the asymptomatic child or adolescent who is screened for diabetes in case of a fasting plasma glucose (FPG) ≥126 mg/dL or a 2-h plasma glucose or random glucose ≥200 mg/dL; however, no further testing is required if specific signs and symptoms of diabetes are present [49]. Type 2 diabetic adolescents have approximately 50% lower insulin sensitivity and 75% lower first-phase insulin secretion when compared to nondiabetic adolescent [50]. Plasma glucose goals for youth diabetics were shown in **Table 3**.

	Adolescents/young adults (13–19 years)	**School age (6–12 years)**	**Toddlers and preschoolers (0–6 years)**
Fasting glucose (mg/dL)	90–130	90–180	100–180
Bedtime/overnight glucose (mg/dL)	90–150	100–180	110–200
HbA1c	<7.5%*	<8%**	<8.5%***

*A lower target (<7.0%) is amenable if excessive hypoglycemia can be prevented.

**If excessive hypoglycemia can be avoided, a lower goal (7.5%) is reasonable.

***If excessive hypoglycemia can be avoided, a lower goal (8%) is reasonable.

Table 3. Targets for plasma glucose [20].

2.3. Dietary management

Nutritional suggestions for children and adolescents with T1DM should focus on a good glycemic control that provides normal growth and development and avoid hypoglycemia [36]. One of the main components of diabetes care and education is the nutritional management. Dietary habits vary according to the culture and socioeconomic status. Cultural, ethnic, and family traditions and the psychosocial requirements should be taken into account in providing nutritional recommendations for children. The entire family should be involved in making the food plan to provide healthy eating habits [51]. MNT is one of the cornerstones of the management of type 1 diabetes in children; however, it is generally one of the most difficult parts of the treatment. Food preferences, cultural influences, physical activity patterns, and family eating habits and schedules should be considered in making an individualized meal plan. Consultation with a registered dietitian to develop a personalized nutrition plan is recommended.

Premeal insulin dosages should be calculated according to the amount of carbohydrate intake that should be consistent. Most of type 1 diabetic children present with weight loss that has to be restored with appropriate management including insulin therapy, hydration, and sufficient energy intake. A nutrition plan updated every year is recommended, since the energy required changes with age, physical activity patterns, and growth rate [49].

Management of type 2 diabetic youth should focus on avoiding sugar-containing beverages and high-fat/high-energy containing foods and providing a regular meal schedule and portion control [50].

Goals of MNT are

1. Sufficient energy intake to provide normal growth and development and integration of insulin dosages with general eating and physical activity habits in type 1 diabetic youth
2. Modify eating and physical activity habits to decrease insulin resistance and enhance metabolic condition in type 2 diabetic youth [36]

Goals of MNT in childhood according to expert consensus:

- Adequate and appropriate intake of energy and nutrients to provide normal growth and development and good health
- Promote healthy, lifelong eating habits to provide and maintain social, cultural, and psychological well-being with considering the patient's wishes and willingness to change
- Manage normoglycemia and avoid hypoglycemia provided by a balance between food intake, metabolic needs, energy expenditure, and insulin regimens
- Maintaining the appropriate BMI and waist circumference.
- Recommend regular physical activity to avoid and manage acute diabetic complications including hypoglycemia, hyperglycemic crises, illness, and exercise-related problems

- Decrease the risk for microvascular complications by providing normoglycemia
- Encourage appropriate nutrient intake and lifestyle to prevent and manage the chronic complications of diabetes, obesity, hyperlipidemia, cardiovascular disorders, hypertension, and nephropathy [52]

Goals for the distribution of total daily energy intake [52];

- Protein 10–15% (decrease by the aging)
- Fat 30–35%:
  - <10% saturated fat + trans fatty acids
  - <10% polyunsaturated fat
  - >10% monounsaturated fat (should be less than 20% of total energy)
  - n-3 fatty acids: 0.15 g/d
- Carbohydrate 50–55%:
- Mainly nonstarch polysaccharide (fiber) containing foods including whole-grain cereals, fruits and vegetables
- Sucrose intake should be less than 10% of total energy

LDL cholesterol and total cholesterol target for diabetic children and adolescents should be <110 mg/dL and <170 mg/dL, respectively [53].

Suggestions for Food Group/Nutrient:

- Fruits/vegetables: Daily 2 cups of fruit and 2.5 cups of vegetables (dark green, orange, legumes, starchy vegetables, and other vegetables) as an approximate total of 2.000 calorie intake is recommended.
- Dairy: Daily 2 cups of fat-free or low-fat milk or equivalent milk products are recommended for children with age between 2 and 8 years. Children ≥9 years old should take 3 cups/day.
- Whole grains: Grains product is frequently recommended, and whole grains should constitute at least half of the grains.
- Carbohydrates: Adequate amount of fiber with fruits, vegetables, and whole grains should be consumed. Excessive amounts of calories from carbohydrates should be prevented.
- Fat: The recommended amount of fat intake is 30–35% of calories for children 2–3 years of age and 25–35% for 4–18 years of age. Avoid excessive intake of fat high in saturated and/or trans fatty acids. Fat-containing more polyunsaturated and monounsaturated fatty acids should be consumed [54]. Carbohydrate counting is an effective way of improving glycemic control, while allowing flexibility in food choice of diabetic children [55].

Family education for choosing foods containing lower saturated and higher monounsaturated fat can ameliorate hyperlipidemia. Approximately 60–70% of total calories consisting of carbohydrate and monounsaturated fat are recommended for diabetic patients by current

guidelines. Using glycemic index is an option in making a diabetic food plan; however, it is not the main suggested method for diabetic food plan in pediatric patients [56].

2.4. Diabetes education

Diabetes education is described as the condition of ensuring an individual with the knowledge and skills required to carry out diabetes self-care and control crises and performing lifestyle modifications to successfully manage the disease. Educational programs with specific aims and learning objectives should be involving diabetic patients, their carers, and families [57].

Appropriate diabetes education is compact and complicated and have the need for educators with a number of abilities such as good communication, compassion, sensitivity, humor, and a comprehensive knowledge of childhood diabetes. The age and developmental stage of the child is a cornerstone of the education such that it should be parents and primary caregivers oriented for a preschooler diabetic as well as patient oriented for most adolescent [49].

Diabetes education should have continuity and repeatability for its effectiveness [57]. Behavioral focus involving the whole family is the key point of a nutrition plan because parents substantially have an impact on eating habits of diabetic children by ensuring the food and promoting to develop food attitudes, preferences, and values.

3. Medical nutrition therapy in elderly diabetics

3.1. Introduction

Diabetes mellitus is a very common disease among elderly individuals, affecting approximately 20% of older adults aged 65–75 years and 40% of adults older than 80 years [58]. Fifty years and older men and women with diabetes live an average 7.5 and 8.2 years less than nondiabetic individuals [59]. Diabetic individuals are 2 to 4 times more likely to have coronary heart disease (CHD) than nondiabetics, and approximately 70–80% of diabetics are dying from CHD [60]. Elderly diabetics have increased the risk of premature death, functional disability, and comorbidities including hypertension, CHD, and stroke. Elderly diabetics also have a higher risk for various known geriatric disorders including depression, cognitive dysfunction, urinary incontinence, fall-related injuries, and persistent pain [61].

Worldwide lifestyle changes cause elevated prevalence of obesity and urbanization, accompanied with higher predicted prevalence of diabetes, particularly among persons 75 years and older [41]. According to national population estimates, there will be a 69% increase in numbers of adults with diabetes in developing countries and a 20% increase in developed countries between 2010 and 2030. Currently, the highest number of people with diabetes around the world is in the 40–59-year-old age-group; however, there will be slightly more people with diabetes in the 60–79-year-old age-group by 2030 [62]. Nutritional evaluation is suggested for all elderly diabetics at the diagnosis time and regularly thereafter, which provide the determination of patients with undernutrition [63].

3.2. Management of diabetes

The general goals of diabetes care in elderly diabetics are similar as in younger diabetic individuals and include control of hyperglycemia and related symptoms; prevention, assessment, and treatment of macrovascular and microvascular complications of diabetes; education for self-management; and maintenance or improvement of general health condition. However, goals are similar in older and younger persons, and the care in elderly diabetics is complicated as a result of their clinical and functional heterogeneity [61]. Hyperglycemia leads to dehydration and impairs vision and cognitive function, contributing to functional decrease and a higher risk of falls in elderly diabetics [64]. Most of the clinicians consider too strict glycemic control (HbA1c of 7%), when compared to poor control (HbA1c >9%), leads to increased risk of wide glucose excursions and hypoglycemia. Therefore, current guidelines recommend a target glycemic range of 7–8.5% in elderly diabetics after explaining their comorbidities.

3.3. Medical nutritional therapy

Food preferences of persons, eating habits, religion and culture, and physical and cognitive health condition should be taken into account while making a nutrition plan. Appropriate amounts of essential vitamins, minerals, protein, and fiber should be included in a meal plan [65].

Diet in an elderly diabetic individual [64]:

- All patients should have a balanced diet
- Generally, a diet not too tight can provide a better quality of life, with little or no effects on glycemic control.
- Elderly individuals carry a higher risk for both undernutrition and obesity.
- Excess weight loss leads to increase the risk of morbidity and mortality in elderly persons.
- Modification of eating habits in elderly persons could be difficult due to consolidated over many years.
- Cognitive impairment or depression may affect cognitive decline or depression

The American Geriatrics Society underlines the significance of MNT in elderly diabetics. Weight loss of 5–10% of body weight is recommended for obese persons. Nevertheless, an involuntary gain or loss of >10 lb. or 10% of body weight during 6 months period should be mentioned in the assessment of the MNT. Energy limitation and physical exercise are required to protect lean body mass. Exercise training attenuates decrease in maximal aerobic capacity, develops during aging, ameliorates atherosclerotic risk factors, protects lean body mass, reduces central obesity, and decreases insulin resistance in elderly diabetics [34].

The prevalence of undiagnosed diabetes in elderly living in the nursing home is not low; however, many of them do not need pharmacologic treatment. Elderly nursing home residents are prone to underweight rather than overweight. Low body weight may lead to higher risk of morbidity and mortality in elderly diabetics. Less restrictive diets are a preferable way of

residents to eat better, since specialized diabetic diets do not seem to be superior to standard diets in this population. Food plans without concentrated sweets or added sugar and liberal diabetic diet are not recommended anymore. Current diabetes nutritional suggestions are not fulfilled by these diets which redundantly limit sucrose intake [34].

3.4. Energy

European Society of Clinical nutrition and Metabolism recommends minimum daily intake of 1.0–1.2 g protein/kg and 20–30 kcal/kg of nonprotein energy for sick elderly patients. The target for nutritional support in malnourished elderly individuals should be a total daily energy intake of 30–40 kcal/kg and a daily protein intake of 1.2–1.5 g protein/kg, according to current geriatric guidelines; however, person-to-person variability for nutritional requirements and physiological and pathological status should be taken into consideration [66].

3.5. Carbohydrate

Carbohydrate intake from vegetables, fruits, whole grains, legumes, and dairy products should be preferred instead of other carbohydrate sources, particularly those that comprise added fats, sugars, or sodium for good health. Consuming LGI food instead of HGI food is better for ensuring good glycemic control and decreasing HbA1c levels [32].

3.6. Protein

Higher protein intake is associated with higher bone mass density, decrease in bone loss, and increase in muscle mass and strength [67–70]. An epidemiologic study reported that higher protein intake decreased health problems in older women [71]. The ADA suggests normal protein intake (15–20% of daily energy) in patients with normal renal function. The data about the safety of high-protein intake are scanty. However, a recent study reported that high-protein diet (approximately 30% of daily energy) provided less glucose-lowering medications after 1 year in elderly type 2 diabetic patients [72]. Kidney Disease Outcomes Quality Initiative of the American National Kidney Foundation (KDOQI) guidelines recommend a daily protein intake of 0.8 g/kg in diabetic patients with chronic kidney disease (CKD); however, there is little evidence related to adults older than 75 years. The results of 5-year prospective cohort study showed that higher daily protein intake (about 1.1 g/kg/day) did not decrease kidney function [73]. Low-protein intake might be associated with a decrease in muscle mass in CKD patients. Therefore, daily energy intake of 30 kcal/kg should be recommended to keep a neutral nitrogen balance [74].

3.7. Fat

A Mediterranean-style, MUFA-rich eating pattern could be recommended as an alternative to a lower fat, higher carbohydrate eating pattern to provide a good glycemic control and decrease the CVD risk factors in type 2 diabetics. The general public recommendation to eat fish (especially fatty fish) at minimum 2 times a week could be applied to diabetic individuals. Diabetic patients should follow nutritional recommendations similar to the general population

to CVD risk factors. These recommendations are decreasing in SFA to 10% of total calories, taking 300 mg daily cholesterol and restriction of trans fat as much as possible [32].

3.8. Fiber

Fiber-containing foods such as legumes, fiber-rich cereals (≥5 g fiber/serving), fruits, vegetables, and whole grain products are recommended for diabetic patients, since they ensure vitamins, minerals, and other substances important for a healthy life. U.S. Department of Agriculture (USDA) recommends 14 g (1000 kcal) daily dietary fiber and foods containing whole grains (one-half of grain intake) in persons with high risk for T2DM [34]. The insoluble dietary fiber in diet decreases cholesterol, glucose, and insulin levels. A fiber-rich meal promotes satiety, since it is processed more slowly in the gastrointestinal tract [75].

3.9. Vitamins

Elderly diabetics are more prone to risk for deficiency of trace elements, and magnesium and zinc supplementation results may worsen glycemic control. Uncontrolled diabetes leads to increase in oxidative stress. Small-size studies showed vitamins C and E (antioxidants) may positively affect glycemic control [76]. Decreased intake and unbalanced diet may lead to a deficiency of vitamins and minerals. Drugs may decrease absorption of vitamins by affecting hepatic metabolism. Older people cannot eliminate vitamin A that may lead to hypervitaminosis. Decreased dietary consumption and gastrointestinal and renal disease lead to vitamin D deficiency which is associated with osteomalacia, rickets, and myopathy. It also leads to decreased bone density, disability, and higher risk for falls. Vitamin deficiency is common in elderly persons. It may lead to macrocytic anemia, subacute combined degeneration of the spinal cord, neuropathies, ataxia, glossitis, and dementia. Vitamin B12 deficiency is also associated with higher levels of homocysteine that may increase the risk for cardiovascular disorders, decreased bone density, and increased fracture risk [77]. Since elderly persons are prone to deficiencies of vitamin B groups (B1, B2, B12, B6, and folate) that lead to cognitive dysfunction, adequate intake of vitamin and micronutrients is essential in elderly diabetics [78].

Conflict of interest

None.

Author details

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