In the Name of God
Medical Nutrition Therapy in Type 2 Diabetes among Pediatrics

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Introduction

The possibility of type 2 diabetes in children and young people with:

- have a strong family history of type 2 diabetes
- are obese at presentation
- are of black or Asian family origin
- have no insulin requirement, or have an insulin requirement of less than 0.5 units/kg body weight/day after the partial remission phase
- show evidence of insulin resistance (for example, acanthosis nigricans).

Currently the only licensed drug treatments for type 2 diabetes in children are insulin and metformin.
The aims of management of type 2 diabetes are:

• Child and family understand the health implications of both obesity and type 2 diabetes.

• Diabetes healthcare professionals understand the health beliefs and behaviours of family to support the development of an effective management plan and achieve optimal blood glucose levels and HbA1c.

• To promote a healthy lifestyle through behaviour change including nutrition, weight management, activity, and smoking.
• Distinction between type 1 and 2 diabetes in children is difficult because autoantigens and ketosis may be present in a substantial number of patients.

• Children with T2DM are usually overweight or obese and present with glycosuria with or without ketonuria, absent or mild polyuria and polydipsia, and little or no weight loss.

• Up to 33% have ketonuria at diagnosis; some may have ketoacidosis without any associated stress, illness, or infection.

2. American Diabetes Association, 2009
**TABLE 9-5  Key Concepts in Diabetes Management**

*Glucose Control*

- Improved glycemic control benefits people with either type 1 or type 2 diabetes.
- For every 1% reduction in results of A1c blood tests (e.g., from 8.0% to 7.0%), the risk of developing microvascular diabetic complications (eye, kidney, and nerve disease) drops by 40%.
- A1c is the primary target for glycemic control. More stringent glycemic goals (i.e., a usual A1c, <6%) may further reduce complications at the cost of increased risk of hypoglycemia. Less-intensive glycemic goals may be indicated in patients with severe or frequent hypoglycemia.
- Postprandial glucose may be targeted if A1c goals are not met despite reaching preprandial glucose goals.
- Goals should be individualized, and lower goals may be reasonable based on benefit–risk assessment.
- Certain populations (children, pregnant women, and elderly) require special considerations. See guidelines:

<table>
<thead>
<tr>
<th>Values by Age (years)</th>
<th>Plasma Blood Glucose Goal</th>
<th>A1c</th>
<th>Rationale</th>
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<tbody>
<tr>
<td>Toddlers and preschoolers age (0–6)</td>
<td>100–180</td>
<td>110–200</td>
<td>&lt;8.5% (but &gt;7.5%)</td>
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<tr>
<td>School age (7–12)</td>
<td>90–180</td>
<td>100–180</td>
<td>&lt;8%</td>
</tr>
<tr>
<td>Adolescents and young adults (13–19)</td>
<td>90–130</td>
<td>90–150</td>
<td>&lt;7%</td>
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<tr>
<td>Adults (20+)</td>
<td>90–130</td>
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<td>&lt;7%</td>
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Nutritional Management
Aims

✓ To encourage **healthy lifelong eating habits** and appropriate eating behavior within the context of the social, cultural and psychological well-being of the child and family.

✓ To establish or maintain eating routines based on **a wide range of nutritious foods** and provide a framework for regular meals

✓ To meet **energy and other nutrient requirements** for normal growth, development and good health.
Aims

• To avoid restrictive eating behaviors that may impact on growth and psychosocial well-being.

• To achieve and maintain appropriate body mass index (BMI).

• To reduce the risk of micro- and macro-vascular complications, particularly cardiovascular disease.

• To develop a supportive relationship to facilitate behaviour change.
Energy Requirement

• Energy requirements will depend on age, sex, size and activity levels.

• Individual assessment of energy requirements will support education about the appropriate amount and distribution of carbohydrate in the diet.
Energy Requirement

• It is important to ensure that total energy intake matches requirements and growth is regularly reviewed.

• Providing a guide to appropriate portion sizes along with promotion of regular physical activity should help prevent excess weight gain.

• It is important to monitor energy intake and growth to identify when advice on prevention of overweight and obesity is needed.
The suggested macronutrient distribution is:

• Carbohydrate 45%-55% energy with moderate sucrose intake up to 10% total dietary energy

• Fat 30%-35% energy with <10% from saturated and trans fatty acids

• Protein 15%-20% energy
Carbohydrate Amount and Type

• Healthy sources of carbohydrate including whole grains, legumes, fruit and vegetables and low fat dairy products should be promoted.

• Carbohydrate management should include information about glycaemic index (GI) to facilitate understanding about the differing glucose responses families may observe when consuming the same quantity of carbohydrate from different food sources.

Carbohydrate Amount and Type

• The reference food is glucose, which has a numerical value of 100.

• Foods ranked as high GI > 70 impact glucose levels quickly, medium GI 55–70 less so, and foods ranked as low GI < 55 impact glucose levels the least quickly.
Carbohydrate Amount and Type

As GI is influenced by a number of factors, including the amount of fat and protein in the food, type of sugar, type of starch and type of fibre, the body’s processing of a low GI food is not always the same as the processing of a ‘healthy’ food.
Carbohydrate Amount and Type

• Children should be encouraged to have carbohydrate sources that are lower in saturated fat.

• Focus on carbohydrate amount alone can result in food choices that are higher in saturated fat and meal and snack patterns that carry a greater risk of dyslipidaemia.

Carbohydrate Counting

The three methods of carbohydrate counting commonly described are:

• Counting in grams
• 15g exchanges
• 10–12g carbohydrate portions

For diabetic patients taking drugs to control blood glucose levels, the distribution of carbohydrate is as follows:

- Breakfast 15%
- First Snack 12.5%
- Lunch 25%
- Second Snack 12.5%
- Dinner 25%
- Last Snack 10%
Fat and Protein

• To ensure that saturated, trans and total fat intake fall within recommendations for the population.

• There is an association between high saturated fat intake and increased insulin requirements, as well as increased risk of cardiovascular disease and obesity.

Fat and Protein

• Protein requirements for growth are the same as for the general population, and intake will vary with age and rates of growth.

• There is likely to be benefit from encouraging vegetable protein sources, such as legumes, as part of a healthy diet.
Fat and Protein

• There is clear evidence that meals higher in total fat and/or protein increase insulin requirements for at least 5–6 hours after eating.

• Fat has been shown to produce delayed hyperglycaemia when consumed with carbohydrate.

• The impact of high protein or high fat with carbohydrate is less than the combined impact of high fat and high protein.
Nutrition Recommendations

• A meal plan based on the individual’s usual food intake should be used.

• Choose a variety of heart-healthy foods, including an average of five servings of fruits and vegetables, six servings of grains (three whole grain), and two servings of low-fat dairy. Foods in the meat and fat groups do not directly affect blood glucose.

• Discourage meal skipping.

American Diabetes Association, 2009
Nutrition Recommendations

• Monounsaturated fatty acids and carbohydrates combined should provide about 60–70% of daily energy intake.

• To reduce the risk of nephropathy, protein intake should be limited to the recommended dietary allowance. If there is microalbuminuria, a more controlled protein intake may be required.

• Include omega-3 fatty acids (as from salmon, mackerel, tuna, walnuts, and canola oil) to control blood lipids and reduce inflammatory processes.

• Encourage regular mealtimes and snacks. Children and teens in particular may need planned snacks.

2. American Diabetes Association, 2009
Nutrition Recommendations

• For minerals, assure adequacy of intake; routine supplementation is not advised.

• Replenish potassium and magnesium, if needed. Adequate calcium is important: 500 mg in 1–3 year olds, 800 mg in 4–8 year olds, 1300 mg in 9–18 year olds, and 1000 mg in adults should be attained daily.

• Daily intake of calcium should be 1–1.5 times the daily requirements to offset poor absorption. Children especially need adequate calcium for growth. Daily intake of phosphorus should be equal to calcium intake.
Fiber

• Children’s diets should contain a variety of fibre containing foods including fruit, vegetables, wholegrains and legumes.

• Recommendations for fiber include rice, beans, vegetables, oat bran, legumes, barley, produce with skins, apples, oranges, other produce. Include 19–38 g/d, larger amounts for older children and teens.

• High fibre diets are associated with reduced risk of cardiovascular disease and improved digestive health.

• Dietary fibre modulates bowel function, fermentation and effects of the gut microbiota.
Fiber

• Eating an age-appropriate amount of fibre is important for glycaemic management, gut health and reduction in cardiovascular risk.

• Practical ways do this include higher fibre breakfast cereals, addition of beans, pulses and lentils to cooked dishes and the use of raw vegetables and fruits as between meal snacks.

Sucrose

• Sucrose can be consumed within the context of a healthy diet.

• Isocaloric (An isocaloric diet is a diet in which you consume the same amount of calories each day from fats, proteins, and carbohydrates) quantities of sucrose and starch increase glucose levels by the same amount.
Sucrose

• Foods containing high amounts of sucrose should be discouraged as a regular component of the diet in line with population guidelines.

• Routine use of sugar-sweetened beverages should be avoided except for the treatment and prevention of hypoglycaemia.

Sucrose

- If foods containing sucrose are chosen, they should be substituted for other carbohydrate foods. Sucrose intakes of 10–35% of total energy intake do not affect on glycemic or lipid responses negatively when substituted for isocaloric amounts of starch.

2. American Dietetic Association, 2009
Sweeteners and Specially Labelled Products

• Non-nutritive sweeteners used commercially can assist in reducing total sucrose intake.

• Advice should be given to avoid excessive consumption, and water should be encouraged as the first-choice drink rather than diet fizzy drinks.
Sweeteners and Specially Labelled Products

• Fructose is not recommended as a sweetener in place of sucrose.

• Internationally, products labelled ‘diabetic’ are not recommended for routine use in the diets of children.

• They are often expensive, contain sweeteners that have a laxative effect (sugar alcohols) and are higher in fat than the product they are replacing.
Salt

- Children with diabetes should follow the same recommendations for salt intake as the general population.

<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>Guideline daily amounts of sodium and salt.</th>
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<tbody>
<tr>
<td>Age</td>
<td>Reference nutrient intake [2] Sodium (g/day)</td>
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<tr>
<td>0–12 months</td>
<td>0.21–0.35</td>
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<td>1–3 years</td>
<td>0.5</td>
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<td>4–6 years</td>
<td>0.7</td>
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<td>7–10 years</td>
<td>1.2</td>
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<tr>
<td>11+ years</td>
<td>1.6</td>
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</tbody>
</table>
Herbs and Supplements in Diabetes Management

• **Aloe vera**
  Studies in Japan found that the phytosterols in aloe vera might play a role in lowering blood glucose levels. Further research is needed.

**Antioxidants**
Antioxidants from food should include good sources of beta carotene, vitamins C and E, selenium and zinc.

• **Chromium**
  Chromium enhances use of insulin. Skin allergies, renal toxicity, and altered iron and zinc absorption can occur. There are no proven benefits if a patient is not deficient.

2. American Diabetes Association, 2009
Herbs and Supplements in Diabetes Management

• **Cinnamon**
  Doses of 1, 3, or 6 g capsules of cinnamon daily lowered blood glucose levels in individuals with diabetes.

• **Gingko biloba**
  It may help control neuropathy by maintaining integrity of blood vessels and reducing stickiness of blood and clotting. It has some antioxidant properties. Avoid taking with warfarin, aspirin, and other anticoagulant drugs. Headache and interactions with other drugs can occur

**Vitamin D**
Supplementation of up to 2000 IU daily in infants were less likely to develop type 1 diabetes over the next 30 years in Finland. This vitamin has a strong, protective effect. Experts are now recommending supplementation at the upper end of the current recommendations (i.e., 1000 IU)
Zinc is part of the production and storage of insulin in the body. Fresh oysters, ginger root, lamb, pecans, split peas, egg yolk, rye, beef liver, lima beans, almonds, walnuts, sardines, chicken, and buckwheat are sources from the diet.

Zinc should not be used with immunosuppressants, tetracycline, ciprofloxacin, or levofloxacin because of potential antagonist effects.
Physical activity and exercise management

- Children with diabetes aged over 5 years should be advised to achieve the World Health Organization recommendation of at least 60 minutes moderate to vigorous activity a day.

- Specific recommendations on promotion of physical activity, including active play and movement, are also available for the under 5s.
Physical activity and exercise management

• Children and young people should be doing aerobic exercise and exercise to strengthen bones and muscles daily.

• Physical activity in type 1 diabetes can be challenging as the normal physiological responses to exercise are disrupted due to the inability to adjust insulin in response to acute changes in glycaemia.
Physical activity and exercise management

• Exercise can be broadly classified into three types based on the predominant energy systems used: aerobic, mixed and anaerobic exercise.

![Aerobic exercise: For example, walking, jogging, cycling. Mixed exercise: For example, team sports – football, basketball, rugby, hockey. Anaerobic exercise: For example, sprint based events – swimming, cycling, track and field athletics.]

**Figure 11.4** Usual glucose responses to exercise. Source: Adapted from Riddell et al. [78]. Reproduced with permission of John Wiley & Sons.
Factors associated with the effect of activity on blood glucose levels are given in Table 11.8.

<table>
<thead>
<tr>
<th>Blood glucose falls</th>
<th>Blood glucose rises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic or low intensity exercise</td>
<td>Anaerobic or high intensity exercise</td>
</tr>
<tr>
<td>Excess insulin</td>
<td>Insufficient insulin</td>
</tr>
<tr>
<td>Prolonged duration</td>
<td>Short duration</td>
</tr>
<tr>
<td>Insufficient carbohydrate</td>
<td>Excess carbohydrate</td>
</tr>
<tr>
<td>Extremes of temperature (cold or hot environment)</td>
<td>Heat stress</td>
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<tr>
<td>Activity within 2 hours of unadjusted insulin bolus</td>
<td>Competitive nature of the sport (adrenalin will increase the blood glucose level)</td>
</tr>
</tbody>
</table>
Hypoglycaemia treatment steps (the 15 minute rule)

Act
- Glucose level below hypoglycaemia threshold
- Treat with 0.3 g/kg glucose

Check
- Wait 15 minutes – repeat glucose check
- Glucose level above 5.5 mmol/L – no further action

Repeat
- Glucose level below treatment target – repeat rescue treatment
Specific Nutritional Aims
• Prevent further **weight gain** in those with a BMI between the 85th and 95th centile.

• Promote **weight loss** for those with a BMI >95th centile with normal linear growth.

• Deal with comorbidities such as hypertension and dyslipidaemia.
The majority of children with type 2 diabetes are overweight.

A focus of nutrition intervention is, therefore, to achieve weight loss or keep weight static with normal linear growth.

Families should be counselled about reducing total energy intake, increasing physical activity and decreasing sedentary behaviours.
Nutritional Assessments
Height-for-age BOYS

2 to 5 years (z-scores)

Height-for-age GIRLS

2 to 5 years (z-scores)
• Older adolescents may benefit from some of the adult programmes offering very low calorie diets.
• Low carbohydrate diets may be appropriate in this group.
• There is some evidence that substitution of low GI foods for high GI foods may help with weight control, lipid levels and control of appetite.
Strategies to **lower total dietary energy intake** include:

Reduction in portion size.
Reduction in consumption of high fat, high sugar food, and drinks.
Cutting out sugary soft or fizzy drinks and fruit juices completely can make the most significant change and result in weight loss.

- These drinks can be replaced with water, diet drinks and sugar-free beverages.

*Clinical Paediatric Dietetics. Book. Shaw et al. Fifth Edition*
• Calculate CHO and fat requirements individually according to age, serum lipid, and glucose levels.

• Studies support the importance of carbohydrate from whole grains, fruits, vegetables, and low-fat milk.

• Extremely low-calorie diets are not recommended for children or teens.

• Spacing of meals (spreading carbohydrate throughout the day) and eating breakfast have beneficial effects on fasting lipid and postprandial insulin sensitivity.

• Meal skipping should be discouraged. Individualize meal plan according to patient preferences.

• For vitamins and minerals, ensure that patient has adequate dietary intakes. Higher levels of magnesium, chromium, and potassium are recommended when serum levels are low.

• There is no need for supplements of any singular nutrient; a pediatric multivitamin–mineral supplement may be used.
• Herbs and botanical supplements should not be used in children and teens.
• The dietitian should regularly reassess children and teens for overall growth and health status.
• Emphasize the importance of regular mealtimes, proper use of medications, and balanced activity. Home blood glucose monitoring records and food/exercise records are important.
• Explain food and nutrition labeling as well as how to manage sucrose, fructose, and sugar alcohols in the diet. Reduce sugar-sweetened beverage intake as much as possible.
• Suggest guidelines for physical activity: three to four times a week, exercise for 30–60 min/d. Aerobic exercise is protective against age-related increases in visceral adiposity.

2. Kim and Lee, 2009
Case Study

- A boy aged 13 years old with type 2 diabetes,
  Weight: 48 kg
  Height: 150 cm
  WC: 80 cm
  Fasting blood sugar: 140 mg/dL

Recall 24h:

صبحانه (حدود ساعت 7/30 صبح): یک عدد تخم مرغ نیمرو، یک عدد نان لواش، چای شیرین (حدود 4 تا 5 قاشق مرباخوری شکر)، یک قاشق غذاخوری خامه و 2 قاشق مرباخوری عسل
میان وعده: یک لیوان شیر کاکائو، یک برش کیک، یک عدد نان لواش به همراه یک قوطی کبریت پنیر، 2 تا 3 عدد کاکائو به همراه چای تا زمان ناهار
ناهار (حدود ساعت 13/30 بعد از ظهر): یک پرس کامل کباب کوبیده به همراه کره چه از بیرون سفارش داده است. یک پیاله ماست موسیر به همراه یک قوطی ماء الشعیر طعم دار
میان وعده: حدود 2 تا 3 برش هندوانه، یک لیوان شیر کاکائو، یک برش کیک، 2 تا 3 عدد کاکائو به همراه چای تا زمان شام
شام (حدود ساعت 19/30 شب): یک عدد ساندویچ همبرگر (به همراه گوجه و خیار)، یک قوطی ماء الشعیر طعم دار
میان وعده: یک کاسه ماست خوری تخمه، یک لیوان شیر تا هنگام خواب، هر لیوان شیر را با 3 عدد خرما مصرف می نماید
Case Study

• $BMI: \frac{48}{(1.50)^2} = 22$

انرژی کل: $16 \times 1500 = 24002$

به دلیل اینکه کودک بايد وزن کم کند از انرژی آن ۴۰۰ کیلوکالری کم کرده و در نهایت رژیم غذایی براساس:

انرژی مورد نیاز: 2000 کیلوکالری

تنظیم می‌شود.
درصد انرژی از کربوهیدرات، پروتئین و چربی

کربوهیدرات:
\[
26 = \frac{6}{2} \div 100 = 0.02 \times 2000 \times \frac{1}{52} = 0.2\%
\]

پروتئین:
\[
9 = \frac{3}{2} \div 100 = 0.03 \times 2000 \times \frac{1}{18} = 0.18\%
\]

چربی:
\[
7 = \frac{9}{2} \div 100 = 0.06 \times 2000 \times \frac{1}{3} = 0.3\%
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<th>3/5</th>
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توزیع مناسب و متعادل واحدهای پیشنهادی گروه‌های غذایی مصرفی

<table>
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نمونه برنامه غذایی

صبحانه (ساعت 7:30): ۲ کف دست نان سنگگ، یک قوطی کبریت پنیر، یک عدد گوجه‌فرنگی و خیار، چای کمرنگ، یک قاشق مرباخوری عسل

میان وعده (ساعت 10): یک لیوان شیر کم چرب، یک عدد سیب، چای کمرنگ و یک عدد خرما

ناهار (ساعت 13): ۱۷ قاشق غذاخوری سرفه برنج، نصف ماهی قزل آلا، یک پیش دستی سالاد یا سبزی خوردن

میان وعده (ساعت 17): چهار عدد زردآلو، یک برش هندوانه، چای کمرنگ و یک حبه قند، ۱۰ عدد مغز مخلوط

شام (ساعت 20): ۱/۵ کف دست نان سنگگ، یک عدد سیب زمینی پخته، ۲ عدد فیله مرغ، ۱ عدد لیوان ماست کم چرب، یک لیوان اسفناج پخته

میان وعده (ساعت 22:30): یک عدد سیب، یک عدد هلو، یک لیوان شیر کم چرب