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Nutrition and Type 2 Diabetes:
Learning Objectives

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1. Discuss the increase in the incidence and prevalence of type 2 diabetes in the population and the shift in age of onset.
2. List the criteria used to identify a person with type 2 diabetes.
3. List the five criteria used to define Metabolic Syndrome (3 out of the 5 are needed for diagnosis).
4. Identify the nutritional factors that have been associated with t2DM and the Metabolic Syndrome and which have been identified as causal factors.
5. Discuss the relative effect of obesity (BMI) vs. quality of dietary intake on t2DM and Metabolic Syndrome.
6. Identify the steps of lifestyle intervention (diet and exercise) that can be used in a clinical setting to prevent/treat type 2 diabetes.

Nutrition and Type 2 Diabetes: Answers to the Learning Objectives

After this lecture the students will be able to:

1. Discuss the increase in the incidence and prevalence of type 2 diabetes in the population and the shift in age of onset.

Diabetes is one of the most common diseases in the US. It is estimated that 16.7 million US adults (about 8% of the total adult US population) have diagnosed diabetes. If undiagnosed diabetes is included, it is estimated that more than 1 in 10 adults in the US has diabetes. Over 93% of patients with diabetes have type 2. Other epidemiologic figures of interest include:

- About 1 million new cases are diagnosed annually.
- The prevalence of diagnosed diabetes increased 61% from 1990 to 2001 – mostly due to the aging of the population and the increase in the prevalence of obesity (the major risk factor for type 2 diabetes), but also due to increased awareness.
- The estimated lifetime risk of developing diabetes if born in 2000 is 35%, while a Hispanic female born in 2000 has a 50% chance of developing diabetes!
- In addition to those with diagnosed or undiagnosed diabetes, close to 15 million people have glucose intolerance, which is considered a pre-diabetic state.

Diabetes discriminates. It afflicts those who can afford it the least (**older** [1 out of 5 individuals over 65 has diabetes], **ethnic minorities** [Hispanics, Non-Hispanic blacks and Asian-Americans], those in **low socioeconomic status**).

Overweight/obesity is the major risk factor for t2DM. Given the increase in the prevalence of overweight/obesity in the population, t2DM is now seen more **in children and adolescents**.

Diabetes is a **serious** disease. People with diabetes and its associated Metabolic Syndrome (see below) have an increased risk for **macrovascular complications (stroke, ischemic heart disease, peripheral vascular disease) and microvascular complications (retinopathy, nephropathy and neuropathy)**.

- Diabetes is the leading cause of **blindness, chronic kidney disease** and non-traumatic **limb amputation** in the US.
- Compared to people without diabetes, persons with diabetes are 2 to 4 times more likely to develop **cardiovascular disease** (heart disease, peripheral disease, stroke)
- Diabetes during pregnancy is a principal cause of **congenital malformations**, perinatal mortality and premature mortality.

2. List the criteria used to identify a person with type 2 diabetes.

Diabetes is a dysmetabolic disorder affecting multiple bodily functions. The diagnosis of diabetes is based on the presence of **hyperglycemia**, as shown below.

Diagnosis of Diabetes Mellitus

Glucose Intolerance:

100 < Morning < FPG 126 mg/dL (IFG)
140 < 2-hour PG < 200 mg/dL (IGT)

Diabetes:

Classic symptoms of diabetes PLUS casual plasma glucose \geq 200 mg/dL or Morning FPG \geq 126 mg/dL or 2-hour PG \geq 200 mg/dL

Unless unequivocal hyperglycemia with metabolic decompensation is present, a diagnosis of diabetes must be confirmed by repeating any of the tests on a different day.

IFG = impaired fasting glucose, IGT = impaired glucose tolerance. Classic symptoms of diabetes include: polyuria, polydipsia, and unexplained weight loss.

Casual is defined as any time of the day without regard to time since last meal. FPG = fasting plasma glucose, defined as no consumption of food or beverage (other than water) for at least 8 hours.

2-hour PG = 2 hour post load glucose during a 75-gram oral glucose tolerance test.

Glucose intolerance, denoted by Impaired Fasting Glucose (IFG) or Impaired Glucose Tolerance (IGT), is not a clinical entity on its own but rather an independent risk factor for progression to clinical diabetes and development of macrovascular complications.

Once diabetes is diagnosed as shown above, then the type of diabetes needs to be defined, **based on etiology**. There are several types of diabetes (to be discussed in detail during 2nd year), the most common ones are type 1 and type 2. **The terms insulin dependent diabetes mellitus and non-insulin-dependent diabetes mellitus and their acronyms, IDDM and NIDDM, have been eliminated.** These terms had been confusing and had frequently resulted in classifying the patient based on treatment rather than etiology. Type 1 is due to autoimmune pancreatic beta cell destruction leading to insulin deficiency and is generally seen in young, thin persons. Type 2 is due to a combination of insulin resistance (impairment in the action of insulin) and relative insulin deficiency, and is generally seen in older, overweight/obese persons.

3. List the 5 criteria used to define Metabolic Syndrome (3 out of the 5 are needed for diagnosis).

In addition to hyperglycemia, t2DM is thought to be related to a cluster of metabolic abnormalities such as central obesity, hypertension, dyslipidemia and increased risk for cardiovascular disease, collectively known as the Metabolic Syndrome. Recently, specific criteria for the metabolic syndrome were defined, as shown below:

Adult Treatment Panel III Diagnostic Criteria for the Metabolic Syndrome

Metabolic Syndrome is defined as having three or more of the following:

Abdominal Obesity

Waist circumference > 102 cm in men and > 88 cm in women

Hypertriglyceridemia	≥ 150 mg/dL
Low HDL	< 40 mg/dL in men and < 50 mg/dL in women
Hypertension	≥ 130/85 mmHg
High Fasting Glucose	≥ 110 mg/dL

4. Identify the nutritional factors that have been associated with t2DM and the Metabolic Syndrome and which have been identified as causal factors.

There are several epidemiologic studies that have identified certain nutritional factors that have been associated with development of t2DM and the Metabolic Syndrome. Causality is suggested by observational prospective studies, but can only be confirmed in randomized trials. The evidence is summarized in the table below.

TABLE 1. Summary of the Evidence for Potential Nutritional Interventions for Prevention or Delay of Type 2 Diabetes

Intervention	Source of Evidence			Recommendation for Prevention of Type 2 Diabetes
	Cohort	Randomized controlled trials	Meta-analyses	
WEIGHT LOSS	↓ Risk	↓ risk*†	–	Weight loss of 7% of initial weight will decrease diabetes risk by 58% over 3 years
MACRONUTRIENTS				
Fat	↑ or ↔ risk	Decreased consumption ↓ risk*	–	Decrease (which leads to weight loss)
Monounsaturated	↓ or ↔ risk	Decreased consumption ↓ risk*	–	Increase for CHD protection
Polyunsaturated	↓ or ↔ risk	–	–	Increase for CHD protection
Saturated	↑ or ↔ risk	Decreased consumption ↓ risk*	–	Decrease for CHD protection
Trans Fatty Acids	↑ or ↔ risk	–	–	Decrease for CHD protection
Nuts and Peanut Butter	↓ risk	–	–	Insufficient evidence
Carbohydrate	↑ or ↔ risk	–	–	Probably no role
Glycemic Index	↓ risk	–	–	Probably a role but insufficient evidence
Cereal Fiber/Whole Grain	↓ risk	↓ risk*	–	Probably a role
Protein	↔ risk	–	–	Probably no role
OTHER				
Alcohol	↓ risk	↓ or ↔ insulin sensitivity	–	For those who desire to drink: 2 drinks/day for men 1 drink/day for women Type of drink not important
Dairy/Calcium	↓ risk	–	–	Insufficient evidence
Caffeine	↓ or ↔ risk	–	–	Insufficient evidence
MICRONUTRIENTS				
Multivitamin	↓ risk	–	–	One multivitamin daily especially in people

Antioxidants	↓ risk	↔ risk	–	with poor dietary habits Probably no role
Vitamin C				
Vitamin E				
Selenium				
Carotenoids				
β-carotene				
Chromium	↓ or ↔ risk	–	↔ risk	Probably no role
Magnesium	↓ risk	–	–	Probably in deficient people but insufficient evidence
Vitamin D	↓ risk	–	–	Insufficient evidence

* As a component of a multicomponent nutritional intervention in the Finish Diabetes Prevention Study.

† As the main component of the nutritional intervention in the Diabetes Prevention ProgramCHD = coronary heart disease.

5. Discuss the relative effect of obesity (BMI) vs. quality of dietary intake on t2DM and Metabolic Syndrome.

Perhaps the most significant modifiable risk factor for the development of t2DM and the MS is obesity. The increase in the prevalence of diabetes in the United States during the last two decades is paralleled by an increase in the prevalence of obesity. However, only a minority of overweight individuals develop clinical diabetes.

There are at least two potential explanations for this observation. The first is that distribution of adipose tissue may be more important than overall weight, with visceral depots contributing more to insulin resistance. The second explanation is that the secretory capacity of the beta islet cell differs between individuals, leading to relative insulin deficiency in the setting of increased insulin requirements in predisposed individuals.

Given the pivotal role of obesity in the development of type 2 diabetes, interventions that result in weight loss are the most effective means in decreasing diabetes risk. This is highlighted by two recently completed large clinical trials for prevention of type 2 diabetes, which are compared in the table shown in the next page. Which method/approach is the most effective one to achieve and maintain weight loss is highly controversial, as discussed elsewhere in this course.

Beyond a reduction in BMI, there is significant evidence to suggest that the quality of the diet may play a role in decreasing risk of t2DM as described in TABLE 1. These nutritional interventions and details regarding their potential mechanism of action will be discussed in class and are also summarized in the required reading.

TABLE 2. Randomized Controlled Trials for Prevention or Delay of Type 2 Diabetes and/or the Metabolic Syndrome.

	Mean	Incidence of
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Study	Intervention	Number of Subjects	Duration of Follow-up (years)	Diabetes (per 100 person-years)	Relative Risk Reduction *	NNT [†]
Finnish Diabetes Prevention Study (DPS)	Intensive Lifestyle Modifications [‡]	265	3.2	3.2	-58%	22 over 1 year 5 over 5 years
Diabetes Prevention Program (DPP)	Control	257		7.8		
	Lifestyle Modifications [§]	1079	2.8	4.8	-58%	16 over 1 year 7 over 3 years
	Metformin 850 mg twice daily	1073		7.8	-31%	31 over 1 year 14 over 3 years
	Control	1082		11		

* In the incidence of clinical diabetes (diagnosed by fasting plasma glucose or oral glucose tolerance test) at the end of the trial compared with control or placebo.

[†] NNT = the number (of patients) needed to treat over a period of time to prevent one adverse outcome.

[‡] DPS Lifestyle Modification: weight reduction of 5% or more, fat intake <30% of total energy, saturated fat intake <10% of total energy, fiber intake >15 g/1000 kcal, frequent ingestion of whole grain, vegetables, fruits, low-fat milk and meat, soft margarine and vegetable oils rich in monounsaturated fatty acids, and moderate exercise >30 minutes/day.

[§] DPP Lifestyle Modification: weight reduction of 7% or more with low-fat diet and moderate physical activity of equal to or more than 150 minutes/week. Interventions achieved through multiple individualized and group sessions.

6. Identify the steps of lifestyle intervention (diet and exercise) that can be used in a clinical setting to prevent/treat Type 2 Diabetes.

Case: A 53-year old man with a family history of t2DM who has been gaining weight steadily over the last two decades was found to have a fasting plasma glucose of 101 by his primary care physician. He is a busy executive of a start-up company with three young children and a spouse who is a cardiothoracic surgeon. He drinks plenty of coffee every day and is worried about adverse effects. He stopped drinking alcohol last year because he is concerned about adverse effects. On exam, his BMI is 29.5 and his BP is 144/86. He is very concerned about his developing t2DM (does not want to be like his father who had both of his legs amputated and died of a heart attack at the age of 74). He is willing to try hard with non-medication interventions. What do you advice?

This is a patient with significant risk factors for progression to t2DM, who is motivated to change but also has a busy lifestyle which limits his opportunities for major lifestyle changes. The focus here is to adapt what you know about t2DM prevention to his lifestyle. He has the luxury of adequate income but not time. First, one needs to get exact information about current activity and nutrition before advice. After reviewing what he does, one focuses on what he can improve. A reasonable lifestyle regimen would be as follows:

- “At all cost”, maintain current weight and, if possible, lose 5% of weight
- If possible, formal exercise (1 hr) 2-3 x /week, 30 mins. aerobic, 30 mins. weight training
- Incorporate exercise during the day (e.g. take stairs, avoid driving, play sports with children, etc.)
- Never skip a meal
- Follow the DASH diet
 - Increase intake of vegetables and fruits to 5-6 cups/portions per day.
 - Choose only lean meats, chicken and fish at 2 servings a day (a serving is 3 oz. which is the size of a deck of cards). All dairy products should be reduced in fat, have 2-3 servings a day.
 - Choose a serving of beans (1/2 cup) or nuts (1/4 cup) each day
- Always have healthy (e.g. whole grain, fruit) snacks available
- Substitute refined carbohydrates with whole grains
- If socially acceptable, share your meal when eating out
- Drink nothing other than water, and, if desired, 1-2 glasses of skim milk/day.
- No need to decrease coffee in relation to t2DM prevention
- No need to eliminate alcohol. 2-3 drinks per day is beneficial in terms of t2DM
- Take a multivitamin
- Check vitamin D level and supplement as needed