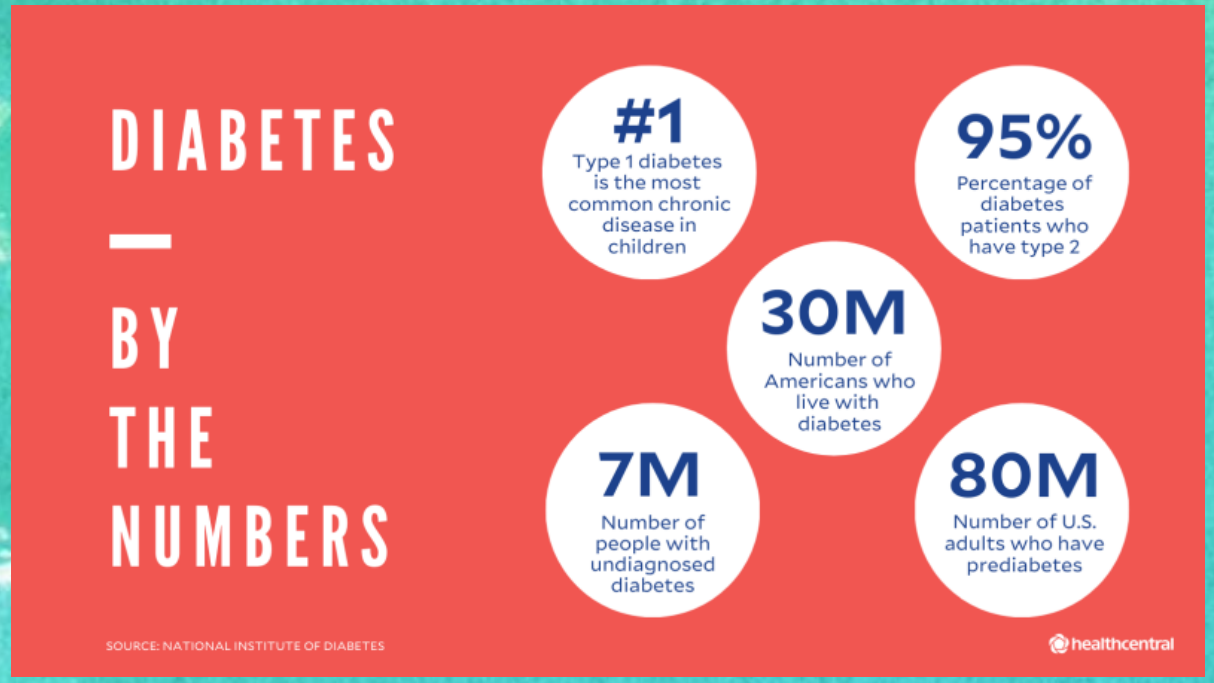
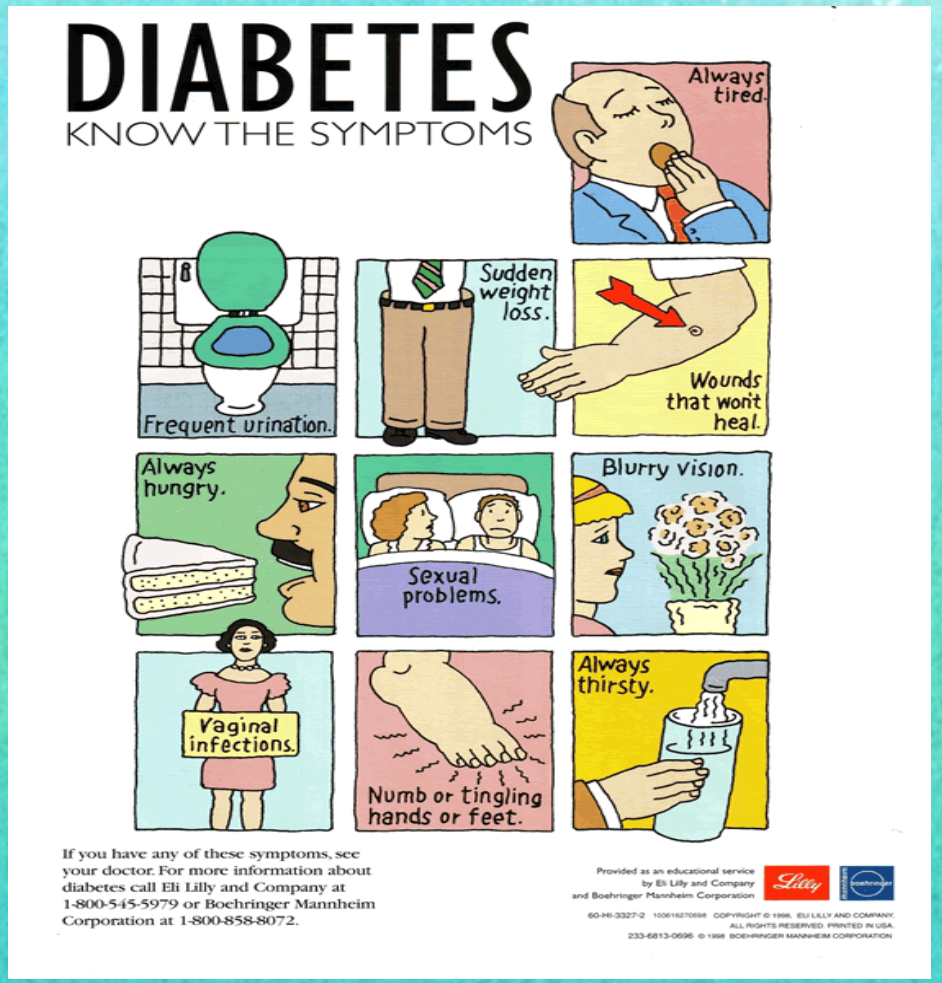
Remedial Physical Education

Diabetes and PE

Department of Adapted PE and Sports Medicine 2020





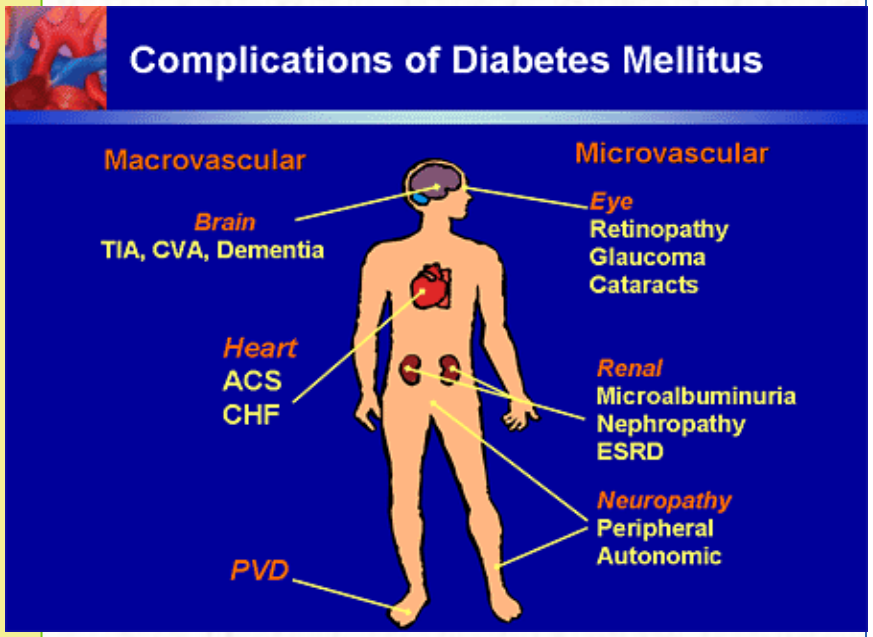
Graphics from: https://www.healthcentral.com/condition/diabetes

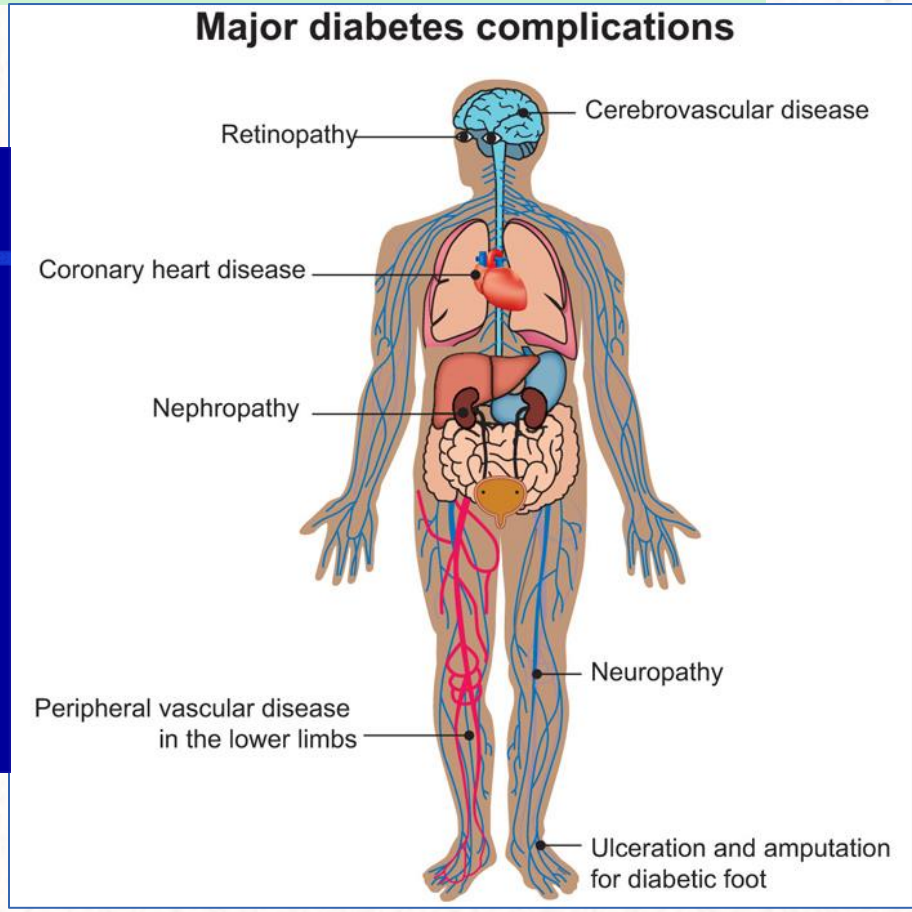
Why should we care of the diabetes topic?

- high morbidity, acute and chronic complications
- part of metabolic syndrome (see next slide), connection with risk factors and other chronic disorders
- physical activity - critical component of diabetes management

DIABETES

- a group of metabolic diseases in which the person **has high blood glucose (blood sugar)**
- insulin production is inadequate, or the body's cells do not respond properly to insulin, or both





The Metabolic Syndrome

combination of medical disorders that, when occurring together, increase the risk of developing cardiovascular disease and diabetes, prevalence in USA: 25%

FOR MEN:

- Waist Circumference ≥ 40 Inches
- Triglycerides ≥ 150 mg/dL
- HDL Cholesterol < 40 mg/dL
- Blood Pressure ≥ 130/85 mm Hg
- Fasting Glucose ≥ 100 mg/dL

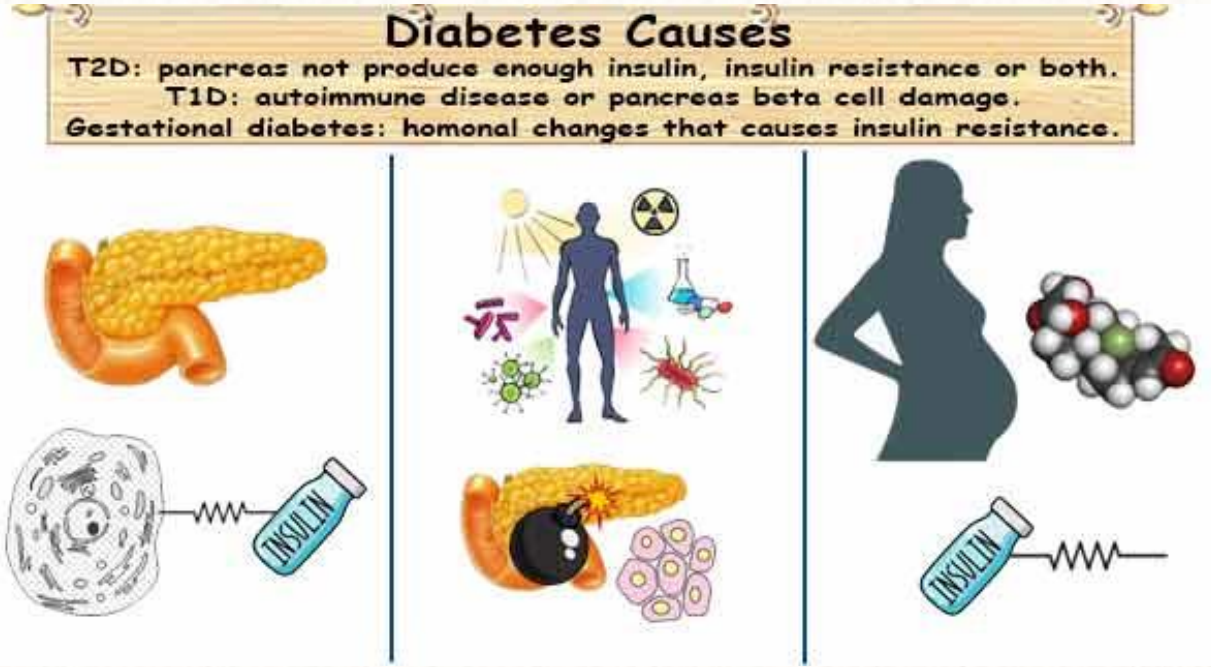
FOR WOMEN:

- Waist Circumference > 35 Inches
- Triglycerides > 150 mg/dL
- HDL Cholesterol < 50 mg/dL
- Blood Pressure > 130/85 mm Hg
- Fasting Glucose > 100 mg/dL

Types of diabetes

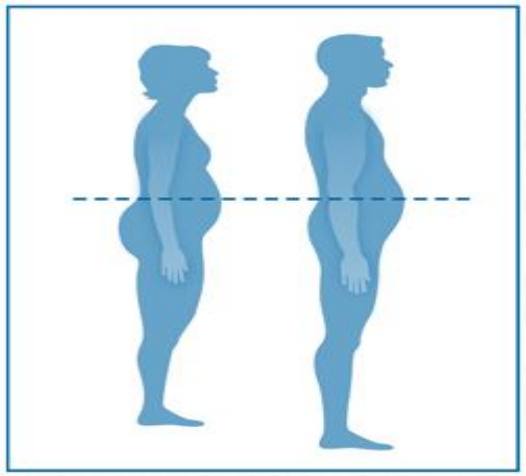
- Type 1 diabetes (Insulin-dependent diabetes, T1DM, „juvenile DM“) – usually begins in younger age, often in non-obese people, there is an absolute lack of insulin, about 10 % of all cases
- Type 2 diabetes (Non-insulin dependent diabetes, T2DM, „adult-onset DM“) – usually begins in middle-age, often in obese people, there is usually a relative lack of insulin (low sensitivity of tissues for insulin), about 90 % of all cases
- Other specific diabetes types (monogenic, secondary etc.)
- Gestational diabetes – DM during pregnancy

Type 1 diabetes usually occurs when the immune system attacks and destroys the insulin-producing beta cells of the pancreas. That may be **caused** by genes and environmental factors, such as viruses, that might trigger the disease.
Type 2 diabetes is more connected with risk factors and sedentary lifestyle.



Picture from: https://healthy-ojas.com/diabetes/diabetes-causes.html

Risk factors for diabetes



- physical inactivity
- parent, brother, or sister with diabetes
- history of giving birth to a baby weighing > 9 lb
- history of gestational diabetes
- high blood pressure
- dyslipidemia
- polycystic ovary syndrome
- prediabetes
- acanthosis nigricans
- history of cardiovascular disease

Symptoms of diabetes

- high sugar in blood /urine
- polyuria – frequent urination
- polydipsia – excessive thirst
- overweight, obesity or sudden weight loss (without any reason)
- frequent infections (skin, urogenital)
- vision impairment

Diagnosing diabetes

Glucose

- *normal 4.0 – 6.0 mmol/l*
- *IGT: 6-7, DM: over 7.1*

OGTT (fasting – 1hr – 2hr)

- *normal up to 6 – 8.8 – 7.8 mmol/l*
- *IGT: up to 7- … - 7.8 – 11 mmol/l*
- *DM: over 7.1 - … - over 11.1 mmol/l*

C-peptid – production of insulin – type of DM

- *normal 1.1 - 3,6 ug/l*

Glycohemoglobin HbA 1c

- *normal compensation: up to 4.5 %*

Blood Test Levels for Diagnosis of Diabetes and Prediabetes

	A1C (percent)	Fasting Plasma Glucose (mg/dL)	Oral Glucose Tolerance Test (mg/dL)
Diabetes	6.5 or above	126 or above	200 or above
Prediabetes	5.7 to 6.4	100 to 125	140 to 199
Normal	About 5	99 or below	139 or below

Definitions: mg = milligram, dL = deciliter
For all three tests, within the prediabetes range, the higher the test result, the greater the risk of diabetes.

To know levels of these parameters is not only important for making diagnosis but also as an evaluation of how the organism is working within the disease. It is important to know for all people who take care of somebody with DM, including teachers and coaches, the **signs of hypoglycemia and hyperglycemia**

LOW BLOOD SUGAR
*Hypo*glycemia

Signs and Symptoms

SWEATING

TREMBLING

DIZZINESS

MOOD CHANGES

HUNGER

HEADACHES

BLURRED VISION

EXTREME TIREDNESS AND PALENESS

HIGH BLOOD SUGAR
*Hyper*glycemia

Signs and Symptoms:

DRY MOUTH

EXTREME THIRST

FREQUENT URGE TO URINATE

DROWSINESS

FREQUENT BED WETTING

STOMACH PAIN

Why do we have higher / lower blood glucose?

High and Low Blood Glucose (hyperglycemia & hypoglycemia) Symptoms and Causes

High Blood Glucose Symptoms (Hyperglycemia)	High Blood Glucose Causes	Low Blood Glucose Symptoms (Hypoglycemia)	Low Blood Glucose Causes
Thirst	Too much food	Shakiness	Too little food
Hunger	Too little exercise	Sweaty	Too much medicine
Frequent urination	Too little medicine	Hunger	More activity than usual
Fatigue	Stress	Anxiety	Too long between meals or snacks
Nausea	Illness	Nervousness	Alcohol
Blurred vision	Injury	Confusion	
Headache	Short time between meals and snacks	Acting angry or irritable	
Nervousness		Slurred speech	
Confusion		Headache	

Handout

Treatment of diabetes

- non-pharmacological:
  - diet
  - exercise
- pharmacological:
  - **Oral anti-diabetics**
    - Biguanides
    - Thiazolidinediones
    - Sulfonylureas
    - Alpha-glucosidase inhibitors
    - Peptide analogues
  - **Insulin and its analogues**
    - insulin Fast-acting, Short-acting, Intermediate-acting, Long acting, Ultra-long acting
    - insulin pump

Graphics from: https://www.healthcentral.com/condition/diabetes

In addition to maintaining cardiovascular fitness and controlling weight, physical activity can help to lower blood glucose levels and increase insulin sensitivity.

The positive effect of exercise on person with T1DM

- The exercise-related protective effects may be mediated in part through:
  - improved insulin sensitivity,
  - decreased weight and visceral fat accumulation,
  - reduced low density lipoprotein (LDL) and triglycerides, increased high density lipoprotein (HDL),
  - decreased blood pressure.

  These effects are more significant in people with T1DM because **hyperglycemia-related morbidity** and mortality are associated with chronic complications. Why?

- Improved insulin sensitivity may determine a better glucose profile which in turn may positively influence the **diabetes-related microvascular complications**

- Improved blood pressure + better lipid profile may contribute to the **prevention of macrovascular complication**

- PA can improve psychological well-being by increasing self-esteem and enhancing quality of life

- Although people with T1DM may participate in all kind of sports and PA, there are several potential adverse events, including hypoglycemic and hyperglycemic episodes, that can occur. Thus, patients and health professionals **have to know in details the physiological effect of physical exercise and its metabolic events in order sport to be healthy and enjoyable…**

The positive effect of exercise on person with T2DM

Where the improvement could be seen?

- cardiovascular
  - autonomic regulation, blood pressure, heart rate
- metabolic + energy balance
  - blood lipids, blood glucose, HbA_{1c}
  - BMI, waist-hip ratio, sagital abdominal diameter
- working capacity
  - VO_2 max, maximal workload, ventilatory threshold
- psychological
  - quality of life, activities of daily living

As you see, effects of exercise are very similar in both DM types.

What is the effect on the disease itself?

- **Lowering the insulinresistance:**
  - – sensitivity of receptors can be increased by daily repeated reaction on dynamic workload
- **Increasing the total amount of receptors**:
  - – absolute amount of receptors can be increased by getting more muscle mass as a result of static workload adaptation

However, in T2DM there is also potential effect on body composition, energy balance / obesity, and **improving function and amount of insulin receptors may actually be a medicine as it can significantly contribute to disease compensation.**

Pupils with diabetes in physical education

- Students with diabetes should participate fully in physical education classes and team sports.
- To maintain blood glucose levels within their target ranges during exercise, **adjustments in insulin and food intake have to made.**
- **To prevent hypoglycemia**, blood glucose levels need to be checked more frequently while engaging in physical activity.
- Physical education instructors and sports coaches **must be able to recognize and assist with the treatment of hypoglycemia**.
- **A quick-acting source of glucose** and the student's glucose meter should always be available, along with water.

Exercise and diabetes in general

- In all cases, diabetes must be „compensated“
- Generally, we can say that glycemia should be not lower than 5 and not higher than 14 mmol/l when starting exercise !!!
- Monitoring of glycemia during exercise is beneficial (if possible)
- People with diabetes should not exercise alone (supervision needed).
- Intensity must be **tailored to actual health status**, and esp. to diabetic complications (be aware of head injury and risk of high blood pressure – risk of bleeding to retina in people with retinopathy, long and intensive exercise may worsen proteinuria in people with nephropathy)
- People with diabetes **should prevent injuries** – the healing processes can be more complicated than in people without diabetes.
- If insulin is used, it should not be applied to muscles which will be directly involved in the exercise.

Exercise and diabetes in general

- Always must be in balance: diet, insulin, exercise…as exercise increases risk of hypoglycemia esp. in T1DM (before and during longlasting aerobic exercise add carbohydrates (in adults T1DM, about 10-20 g carbohydrates in fluid every 30 min of exercise), in T1DM exercise should be done ideally daily in the same time (+ according experience and measurements decrease insulin dose before exercise, usually about 2-4 units /tables and own experience/).
- Exercising soon after meal (time of maximal need of insulin) is not recommended.
- Exercising in the evening is not recommended because of higher risk of night hypoglycemia.
- Diabetic athletes / pupils in PE, must have always fast glucose source with them.

Case study 1 (effect of 3month exercise program)

male patient with NIDDM, 44 yrs, treated with oral antidiabetic agents

		After 3 months
BMI	45,7	42,1
Weight (kg)	140	129
Waist (cm)	128	124
Hip (cm)	118	111
VO_2max (ml/min/kg)	22,3	38
W/kg	1,5	2,8
HbA_{1c} (%)	9,8	4,8

Tasks for distance study

Please go through the **presentation and read attached scientific articles. As there is no „special compensatory exercise for diabetes“, please train the 10 „control exercises“, which are part of your practical examination.**

Also, please answer 3 following questions:

1. What is HbA1c and why is this parameter important?
2. What exercise type, frequency, duration, and intensity is recommended to adults with T2DM?
3. What are the main risk factors for post-exercise hypoglycemia?