Diabetes

Topics include:

- Types of diabetes
    - Prevalence
    - Risk factors
- Characteristics and diagnostic criteria
- Treatment strategies
    - Activity
    - Pharmacological
    - Nutrition
- Considerations and contraindications

Background

Diabetes mellitus (DM) affects over 30 million individuals in the United States, and is accountable for almost 80,000 deaths annually, and indirectly accountable for over 250,000 additional deaths. Diabetes is the 7th leading cause of death in the United States with an estimated cost of almost $250 billion annually (Centers for Disease Control and Prevention [CDC], 2017). There are over 1.5 million new cases reported every year, and over 84 million U.S. adults are considered pre-diabetic (CDC, 2017). Risk factors are smoking, obesity or overweight, sedentary lifestyle, high blood pressure, and high cholesterol. Cardiovascular disease, including ischemic heart disease and stroke, is a major complication associated with DM, affecting close to 1.5 million adults. Other complications of DM are lower limb amputation (100,000+ adults), diabetic ketoacidosis (170,000 adults), abnormal protein metabolism, retinopathy, and neuropathy (CDC, 2017; Verity, 2015)

The incidence of Type I diabetes (T1DM) is only 5-10% of the total of people diagnosed with diabetes, leaving the remaining 90-95% diagnosed with Type II diabetes (T2DM) (Colberg et al., 2016; Verity, 2015). DM results when there is a disruption in the production of insulin, causing hyperglycemia, or increased blood glucose (American College of Sports Medicine [ACSM], 2018). T1DM is an autoimmune disease that damages the pancreas and it does not produce insulin; in T2DM, the pancreas produces insulin, but due to insulin resistance or the lack of sensitivity to insulin in adipose tissue, the liver, or muscle cells, it cannot produce enough, resulting in an absolute or relative lack of insulin.

Diagnostic Criteria

There are a number of tests available to determine a diagnosis of DM. The A1C test measures a person's average blood glucose for the previous 60-90 days, a fasting plasma

glucose (FPG) test checks fasting blood glucose levels, an oral glucose tolerance test (OGGT) tests blood glucose levels over a 4-hour period, and a random plasma glucose test checks blood glucose levels at any time of the day. Only a physician can make a diagnosis of diabetes, and testing should take place in a health care facility with professionally trained clinicians. Table 10.1 lists the criteria for a diagnosis of diabetes based on results from the various tests.

Table 10.1

Criteria for diabetes assessments

Method / Result	A1C	FPG	OGTT	Random
Normal	< 5.7	<100mg/dl	<140 mg/dl	n/a
Pre-diabetic	5.7-6.4	100 mg/dl -125 mg/dl	140 mg/dl -199 mg/dl	n/a
Diabetic	≥6.5	≥126 mg/dl	≥200 mg/dl	>200 mg/dl

American Diabetes Association, 2019; Verity, 2015

Treatment Strategies

Exercise

For clients with T1DM, exercise is not an effective means to control blood glucose levels (ACSM, 2018; Verity, 2015). However, because many people with T1DM are often sedentary, overweight or obese, have hypertension or dyslipidemia, it is important for them to maintain a regular exercise schedule. Additionally, because cardiovascular disease is the leading cause of morbidity and mortality in people with T1DM, regular exercise can alleviate or the lower risk of cardio-metabolic disease (Colberg et al., 2016; Riddell et al., 2017; Verity, 2015).

For clients with T1DM, exercise can be used, in addition to proper nutrition and medication, to improve insulin sensitivity and lower A1C. Other benefits include lower blood pressure and cholesterol, weight maintenance or loss, increased energy, improved circulation, and decreased insulin resistance. It is recommended clients with DM be active 5-7 days per week, beginning with 20 minutes per day that can be split into shorter sessions, and

progressing to 60 minutes per day, using a combination of aerobic and resistance training (ACSM, 2018). High-intensity interval training (HIIT) can also be used as means to promote skeletal muscle oxidative capacity, insulin sensitivity, and glycemic control for clients with T2DM, and will not hinder glycemic control for clients with T1DM (Colberg et al., 2016). Keep in mind metabolic conditions such as diabetes often occur in conjunction with other chronic conditions such as HTN, CVD, and pulmonary disorders, and the FITT guidelines for comorbid conditions need to be individually considered. FITT Guidelines for clients with diabetes are in Table 10.2.

Table 10.2

FITT guidelines for diabetes

Diabetes	Frequency	Intensity	Time	Type	Notes
Aerobic	3-7 days/week	Moderate to vigorous: 40-80 HRR RPE 12-16	20-60 min/bout 150 min/week moderate 90 min/week vigorous	Exercises that target large muscle groups: Walk, jog, cycle, swim	For clients without contraindications, vigorous intensity, to include HIIT, should be considered
Resistance	2-3 non-consecutive days/week	60-80%1RM RPE 11-15	8-12 exercises 1-4 sets Moderate: 8-12 reps Vigorous: 6-8 Reps	Major muscle groups 4-5 exercises each for upper and lower body	Begin moderately Increase weight and lower reps, then increase sets, and then the number of bouts
Flexibility	2-3 days/week	Stretch to ROM tightness	15-30 sec/stretch 2-4 reps/stretch	4-5 exercises each for upper and lower body	Can perform static or dynamic and increase time or reps as is warranted by progress
Neuromuscular	2-3 days/week	Light to moderate	Incorporate into other workouts	Single leg functional movements Yoga, Tai Chi	Increase time or reps as progress is warranted

ASCM, 2018; Colberg et al., 2016; LaFontaine, Roitman, & Sorace, 2018; Verity, 2015

Exercise and Medications

There are several medications prescribed for diabetes that control symptoms (Table 10.3). For example, hypoglycemia is a common occurrence for diabetics; particularly during exercise. Clients with T1DM do not have a uniform response to exercise; therefore, determining a dose-response relationship to exercise is difficult, and exercise may prompt a hypoglycemic event. While aerobic exercise is known to decrease blood glucose levels, resistance training is known to lessen the risk of exercise- induced hypoglycemia. To reduce the chance of exercise-induced hypoglycemia for clients with T1DM, resistance exercise is recommended prior to aerobic exercise (Colberg et al., 2016). For clients with T2DM, exercise can result in lower blood glucose levels, and the more physical activity that is performed, the lower the insulin resistance and the greater the insulin sensitivity. Additionally, clients with T2DM can suffer from abnormal insulin secretion, and when coupled with exercise, may result in hyperinsulinemia instigating a hypoglycemic event. Continuous glucose monitoring can determine a hypoglycemic event, allowing appropriate action if needed.

Table 10.3

Common diabetes medications

Medication	Mechanics	Side effects	Exercise considerations
Type I diabetes			
Insulin Sort, intermediate, and fast acting	Supplies insulin because the pancreas is does not	Injection site irritation Hypoglycemia	Injected insulin may release faster during exercise Exercise increase glucose uptake which may result in hypoglycemia
Pramlintide	Blunts blood glucose levels following eating	Injection site irritation Poor appetite Lethargy	May result in decreased performance
Type II diabetes			
Insulin	Supplies insulin when the pancreas is unable to	Injection site irritation Hypoglycemia	Injected insulin may release faster during exercise Exercise increase glucose uptake which may result in hypoglycemia

Sulfonylureas	Stimulates pancreas to release insulin	Hypoglycemia Weight gain Nausea	Risk of hypoglycemia Blood sugar levels need to be monitored during first few sessions, until response to exercise can be predicted
DPP4 inhibitors	Stimulates the release of insulin Inhibits the release of glucose from the liver	Respiratory tract infection Headache	Unknown Possibly hypoglycemia
Biguanide	Improves insulin sensitivity Inhibits the release of glucose from the liver	Nausea Diarrhea	Exercise may hinder drug actions May increase heart rate response to exercise
Thiazolidinedione	Improves insulin sensitivity Inhibits the release of glucose from the liver	Cardiac events Liver disease	Strong possibility of hypoglycemia
Alpha-glucose inhibitors	Slows the breakdown and absorption of carbohydrates	GI distress Diarrhea	Strong possibility of hypoglycemia

LaFontaine et al., 2018

Dietary Considerations

Lifestyle in intervention is critical to mitigate the consequences of DM, as well as prevent, delay, or reverse comorbidities. For clients with prediabetes a reduction of 5-7% of bodyweight is suggested combined with the recommended exercise (Table 10.2) can delay the progression to T2DM by almost 60% (Dyson et al., 2011; Verity, 2015). A medical fitness practitioner (MFP) needs to be aware of any dietary restrictions or modifications as these may have an effect on exercise performance. The following guidelines summarize recommendations for the prevention of prediabetes and the management of DM (Asif, 2014; Dyson et al., 2011; LaFontaine et al., 2018. Verity, 2015).

Everyone with prediabetes or diabetes should consult a registered dietician.

- Weight loss should be the main goal
    - Energy restriction
    - Low-fat diets
    - Increased physical activity
    - Monitor glucose and carbohydrate consumption and adjust insulin accordingly
- Diets should be low glycemic and high in fiber
- Vegan diets can moderate the effects of diabetes by up to 43%
- Diets should include
    - Low-fat dairy foods
    - Green leafy vegetables
    - Carbohydrates should be starch (rice, beans, potatoes)
    - Moderate alcohol consumption
- Foods to avoid are
    - Red meats
    - Animal fats
    - Processed products
    - Refined sugar except during sever hypoglycemic episodes
    - Fried foods
    - Salt
- Micronutrient considerations
    - Plant sterols and stanols may benefit blood lipid profile
    - Vitamins A, C, E, or carotene may be helpful
    - Limit sodium to 2300mg/day

Complications and Concerns

Microvascular or neural disease are common complications of diabetes, and even though regular exercise may prevent or delay onset, it is prudent to be aware of neuropathy, retinopathy, and nephropathy. Neuropathy is weakness, numbness, and pain from nerve damage, usually in the hands or feet. If a client has been diagnosed with neuropathy, to mitigate skeletomuscular injuries, particularly in the extremities, avoiding vigorous exercise such as plyometrics is advised. Accordingly, incorporating non-weight bearing exercise may be prudent. Cardiac autonomic neuropathy can exacerbate cardiovascular disorders in diabetics, including a blunted heart rate response, and sudden variations in orthostatic blood pressure. Using the RPE scale to determine intensity may be necessary, and sudden postural or directional changes should be avoided (Colberg et al., 2016). Clients with DM have a high risk for retinopathy, or retinal detachment. Clients diagnosed with retinopathy should avoid high intensity exercise and limit systolic blood pressure to 20-30 mmHg above resting. Nephropathy, or kidney damage, is experienced by 30% of diabetics, and the risk is increased as blood pressure rises. Clients with nephropathy can benefit from low intensity exercise and should limit SBP to 180-200 mmHg. High-intensity weight training that may induce the Valsalva maneuver should be avoided (Verity, 2015). For most clients with DM, the benefits of exercise outweigh the involved risks, but a MFP should be aware of the precautions listed below:

- Be cautious of the side effects of medication.
- Hypoglycemia may occur as a response to exercise in clients with T2DM as a result of hyperinsulinemia

- Previously sedentary clients may need to start at a very low intensity for both aerobic and resistance training.
- It may be necessary to use RPE for clients with diabetes because of an altered max HR due to cardiac autonomic neuropathy.
- A medical clearance is not always necessary for asymptomatic clients, but due to the risk of a cardiac event, it is prudent to get clearance.
- A medically supervised exercise test may need to be performed prior to beginning an exercise program – consult with a client's physician.
- Hypoglycemia is the most common response to exercise (a blood glucose of >70 mg/dl). Symptoms include profuse sweating, cold and clammy skin and appearance, persistent shaking, confusion, slurred speech, and dizziness or fainting.
- If a client is displaying hypoglycemic symptoms, a simple sugar snack containing 20-30 grams of carbohydrates can help.
- For a client with diabetes, 15-30 grams of carbohydrates should be consumed every 30 minutes of moderate exercise.
- Blood glucose should be monitored prior to, during, and after exercise.
- Be cautious of dehydration.
- Clients with retinopathy or neuropathy should avoid vigorous exercise due to a higher risk for retinal detachment and hemorrhage.
- Because 75% of individuals with T2DM will die from a cardiovascular event, be cautious and aware when performing vigorous exercise

Discussion and application

1. Identify the components of a medical team, and how a Health and Fitness Professional fits into the overall medical team to address a client/patient with diabetes.
2. Define and discuss ways to avoid exercise-induced hyperglycemia and post-exercise hypoglycemia.

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