Exercise and Diabetes

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Outlines

- Types of exercise
- Benefits of exercise
- Exercise training recommendations
- Pre-exercise health screening and evaluation
- Exercise-related adverse events
- Recommendations for exercise with health-related complications

Types of exercise

Aerobic

"Cardio"

- เน้นพัฒนาระบบการหายใจและระบบไหลเวียนโลหิต
- เช่น เต้นแอโรบิค วิ่ง ปั่นจักรยาน ว่ายน้ำ เป็นต้น

Resistance

- การออกกำลังกายที่เน้นการสร้างความแข็งแรงให้กับกล้ามเนื้อ
- เช่น ยกเวท วิดพื้น ซิทอัท เป็นต้น

Flexibility

- การออกกำลังกายที่เน้นเพิ่มความยืดหยุ่นให้กับกล้ามเนื้อส่วนต่างๆ
- เช่น โยคะ ไทชิ ชี่กง ไทเก็ก เป็นต้น

Benefits of exercise

- Aerobic
  - Lower cardiovascular and overall mortality risks in both type 1 and type 2 diabetes
  - Type 1 DM : increases cardiorespiratory fitness, decreases insulin resistance, improves lipid levels and endothelial function
  - Type 2 DM : Reduces A1C, triglycerides,BP and insulin resistance

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Benefits of exercise

- Resistance
  - Improves muscle mass, body composition, strength, physical function, mental health, BMD, insulin sensitivity, BP, Lipid profiles and cardiovascular health.

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Benefits of exercise

- Flexibility and balance
  - Stretching : increases range of motion around joints and flexibility BUT does not effect glycemic control
  - Balance : reduces falls risk

Exercise training recommendations

Aerobic exercise training

- ✓ At least 150 min/week (30min/day x 5 days or three10-min session/day) at moderate to vigorous intensity

No more than 2 consecutive days without exercise!!!

Moderate intensity = HR 50-70 % MHR (220- Age)

Examples of Moderate Exercise	Examples of Vigorous Exercise
• Walking briskly (3 miles per hour or faster, but not race-walking) • Water aerobics • Bicycling slower than 10 miles per hour • Tennis (doubles) • Ballroom dancing • General gardening	• Racewalking, jogging, or running • Swimming laps • Tennis (singles) • Aerobic dancing • Bicycling 10 miles per hour or faster • Jumping rope • Heavy gardening (continuous digging or hoeing, with heart rate increases) • Hiking uphill or with a heavy backpack

Resistance exercise training

- ✓ 2-3 days/week
- ✓ At least 8-10 exercises
- ✓ 1-3 sets of 10-15 repetitions to near fatigue per set

- Resistance machines
- Free weights
- Resistance bands
- Body weight

No more than 2 consecutive days without exercise!!!

Flexibility , Balance training

- ✓ 2-3 days/week

- ✓ Stretching : static , dynamic, and other stretching ; yoga
- ✓ Balance (for old adult): practice standing on one leg,exercise using balance equipment, lower-body and core exercises,tai chi

- ✓ Balance training can be any duration

- ✓ Stretch to the point of tightness or slight discomfort
- ✓ Hold for 10-30 s ; 2-4 repetitions of each exercise

Reduced sedentary time !!!

- Prolonged sitting should be interrupted with bouts of light activity every 30 min for blood glucose benefits

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Pre-exercise health screening and evaluation

- Physical activity dose carry some potential health risks for people with diabetes
  - Cardiac events
  - Hypoglycemia esp. type 1 diabetes
  - Hyperglycemia

Pre-exercise health screening and evaluation

- The American College of Sports Medicine (ACSM) proposed a new model for exercise preparticipation health screening on basis of

1. The individual's current physical activity levels
2. The presence of sign or symptoms and/or known cardiovascular, metabolic, or renal disease
3. The desired exercise intensity

Pre-exercise health screening and evaluation

- Physical examination and a resting ECG : in sedentary adults(age > 50 years)
- Exercise stress test for asymptomatic individuals at high risk for CAD;
  - peripheral or carotid atherosclerotic vascular disease
  - renal disease
  - abnormal resting ECG
  - multiple diabetes complications
- High-risk patients : start with periods of low-intensity exercise and slowly increase the intensity and duration

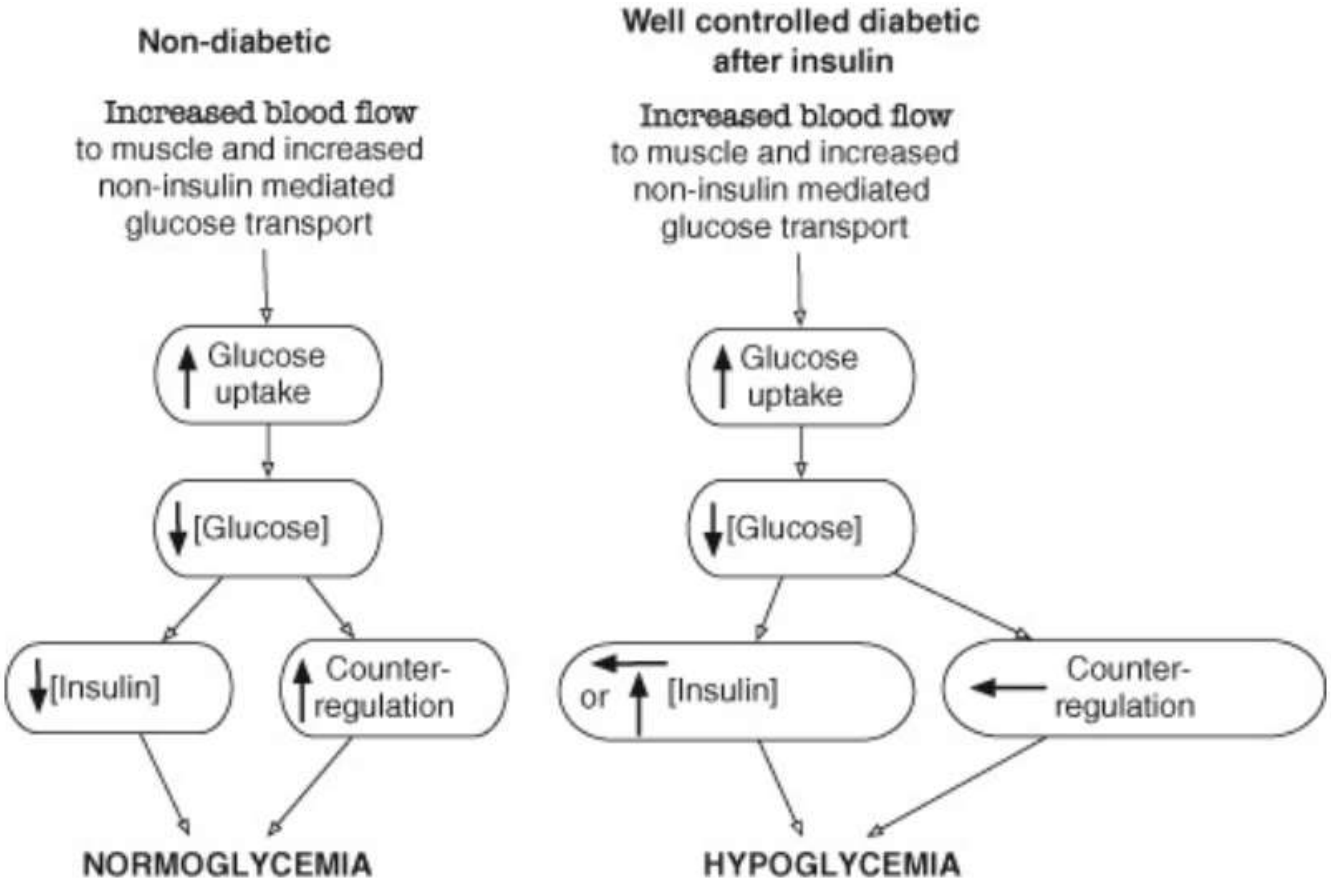
Contraindications for exercise

- Unstable angina
- Uncontrolled sinus tachycardia
- Uncompensated congestive heart failure
- Active pericarditis or myocarditis
- Acute systemic illness or fever
- Severe orthopedic conditions that would prohibit exercise

Contraindications for exercise

- Uncontrolled diabetes (BS > 250 with ketone in urine or blood)
- Untreated proliferative retinopathy
- Recent significant retinal hemorrhage
- Acute or uncontrolled renal failure

Physiologic responses to exercise in the diabetic and non-diabetic individual



Management of food and insulin with physical activity

Pre-exercise blood glucose	Carbohydrate intake or other action
< 90 mg/dL	• ถ้าออกกำลังกายเกิน 30 นาที ให้กินคาร์บ 15-30 g (1-2 carb) ก่อนเริ่ม • ถ้าต้องออกกำลังกายโดยใช้เวลานาน เช่น มาราธอน ต้องกินคาร์บเพิ่ม 1-2 carb/ hr
90-150 mg/dL	• กิน 1-2 carb/ hr of exercise ตอนเริ่มออกกำลังกาย
150-250 mg/dL	• ยังไม่ต้องกิน carb จนกว่า blood sugar < 150 mg/dL

Adapted from Zaharieva and Riddle

Management of food and insulin with physical activity

Pre-exercise blood glucose	Carbohydrate intake or other action
250-350 mg/dL	• ตรวจ ketones , ห้ามออกกำลังกาย ถ้าตรวจพบ moderate-to-large amounts of ketones • initiate mild-to0moderate intensity exercise. • intense exercise ควรเริ่มเมื่อ blood sugar < 250 mg/dL
> 350 mg/dL	• ตรวจ ketones , ห้ามออกกำลังกาย ถ้าตรวจพบ moderate-to-large amounts of ketones • ถ้า ketones negative(or trace) พิจารณาฉีด insulin เพิ่มก่อนออกกำลังกาย • initiate mild-to-moderate exercise and avoid intense exercise จนกว่า glucose level จะลดลง

Reductions in basal and/or bolus insulin dose

- Premixed insulin → not flexible to adjust dose to control blood sugar
- Basal bolus

Table 2—Suggested initial pre-exercise meal insulin bolus reduction for activity started within 90 min after insulin administration

	Exercise duration	
Exercise intensity	30 min	60 min
Mild aerobic (~25% VO_{2max})	−25%*	−50%
Moderate aerobic (~50% VO_{2max})	−50%	−75%
Heavy aerobic (70%−75% VO_{2max})	−75%	N-A
Intense aerobic/anaerobic (>80% VO_{2max})	No reduction recommended	N-A

Recommendations compiled based on four studies (94–97). N-A, not assessed as exercise intensity is too high to sustain for 60 min. *Estimated from study (95).

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Exercise-related adverse events

- Hypoglycemia
  - common in type 1 diabetes
  - type 2 diabetes using insulin or insulin secretagogues.
  - exercise – induced nocturnal hypoglycemia
    - occur typically within 6-15 hr postexercise
    - minimized the risk by 20% reductions of daily basal insulin dose with reduced prandial bolus insulin at evening exercise

Exercise-related adverse events

- Hyperglycemia
  - common in type 1 diabetes
  - type 2 diabetes may also experience hyperglycemia after aerobic or resistance exercise
  - very intense exercise such as sprinting,heavy powerlifting may promote hyperglycemia

Exercise-related adverse events

- Medication effects

Table 4—Exercise considerations for diabetes, hypertension, and cholesterol medications and recommended safety and dose adjustments

Type/class of medication	Exercise considerations	Safety/dose adjustments
Diabetes		
Insulin	• Deficiency: hyperglycemia, ketoacidosis • Excess: hypoglycemia during and after exercise	• Increase insulin dose pre- and postexercise for deficiency • Decrease prandial and/or basal doses for excess insulin
Insulin secretagogues	• Exercise-induced hypoglycemia	• If exercise-induced hypoglycemia has occurred, decrease dose on exercise days to reduce hypoglycemia risk
Metformin	• None	• Generally safe; no dose adjustment for exercise
Thiazolidinediones	• Fluid retention	• Generally safe; no dose adjustment for exercise
Dipeptidyl peptidase 4 inhibitors	• Slight risk of congestive heart failure with saxagliptin and alogliptin	• Generally safe; no dose adjustment for exercise
Glucagon-like peptide 1 receptor agonists	• May increase risk of hypoglycemia when used with insulin or sulfonylureas but not when used alone	• Generally safe; no dose adjustment for exercise but may need to lower insulin or sulfonylurea dose
Sodium–glucose cotransporter 2 inhibitors	• May increase risk of hypoglycemia when used with insulin or sulfonylureas but not when used alone	• Generally safe; no dose adjustment for exercise
Hypertension		
β-Blockers	• Hypoglycemia unawareness and unresponsiveness; may reduce maximal exercise capacity	• Check blood glucose before and after exercise; treat hypoglycemia with glucose
Other agents	• Regular exercise training may lower blood pressure; some agents increase risk of dehydration	• Doses may need to be adjusted to accommodate the improvements from training and avoid dehydration
Cholesterol		
Statins	• Muscle weakness, discomfort, and cramping in a minority of users	• Generally safe; no dose adjustment for exercise
Fibric acid derivatives	• Rare myositis or rhabdomyolysis; risk increased with gemfibrozil and statin combination	• Avoid exercise if these muscle conditions are present

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Exercise-related adverse events

- Heat-related illness during physical activity
  - with increasing age,poor blood glucose control,and neuropathy, skin blood flow and sweating may be impaired in adults with type 1 and type 2 diabetes.
  - Older adults with diabetes or anyone with autonomic neuropathy, cardiovascular complications,or pulmonary disease should avoid exercising outdoors on very hot and/or humid days.

Recommendations for exercise with health-related complications

Table 5—Physical activity consideration, precautions, and recommended activities for exercising with health-related complications

Health complication	Exercise considerations	Physical activity recommendations/precautions
Cardiovascular diseases		
Coronary artery disease	• Coronary perfusion may actually be enhanced during higher-intensity aerobic or resistance exercise.	• All activities okay. • Consider exercising in a supervised cardiac rehabilitation program, at least initially.
Exertional angina	• Onset of chest pain on exertion, but exercise-induced ischemia may be silent in some with diabetes.	• All activities okay, but heart rate should be kept ≥10 bpm below onset of exercise-related angina.
Hypertension	• Both aerobic and resistance training may lower resting blood pressure and should be encouraged. • Some blood pressure medications can cause exercise-related hypotension.	• Ensure adequate hydration during exercise. • Avoid Valsalva maneuver during resistance training.
Myocardial infarction	• Stop exercise immediately should symptoms of myocardial infarction (such as chest pain, radiating pain, shortness of breath, and others) occur during physical activity and seek medical attention.	• Restart exercise after myocardial infarction in a supervised cardiac rehabilitation program. • Start at a low intensity and progress as able to more moderate activities. • Both aerobic and resistance exercise are okay.

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Recommendations for exercise with health-related complications

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Health complication	Exercise considerations	Physical activity recommendations/precautions
Stroke	• Diabetes increases the risk of ischemic stroke. • Stop exercise immediately if symptoms of a stroke (occurring suddenly and often affecting only one side of the body) happen during exercise.	• Restart exercise after stroke in a supervised cardiac rehabilitation program. • Start at a low intensity and progress as able to more moderate activities. • Both aerobic and resistance exercise are okay.
Congestive heart failure	• Most common cause is coronary artery disease and frequently follows a myocardial infarction.	• Avoid activities that cause an excessive rise in heart rate. • Focus more on doing low- or moderate-intensity activities.
Peripheral artery disease	• Lower-extremity resistance training improves functional performance (161).	• Low- or moderate-intensity walking, arm ergometer, and leg ergometer preferred as aerobic activities (162). • All other activities okay.

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Recommendations for exercise with health-related complications

Table 5—Physical activity consideration, precautions, and recommended activities for exercising with health-related complications

Health complication	Exercise considerations	Physical activity recommendations/precautions
Nerve disease		
Peripheral neuropathy	• Regular aerobic exercise may also prevent the onset or delay the progression of peripheral neuropathy in both type 1 and type 2 diabetes (163).	• Proper care of the feet is needed to prevent foot ulcers and lower the risk of amputation (6). • Keep feet dry and use appropriate footwear, silica gel or air midsoles, and polyester or blend socks (not pure cotton). • Consider inclusion of more non–weight-bearing activities, particularly if gait altered.
Local foot deformity	• Manage with appropriate footwear and choice of activities to reduce plantar pressure and ulcer risk (164).	• Focus more on non–weight-bearing activities to reduce undue plantar pressures. • Examine feet daily to detect and treat blisters, sores, or ulcers early.

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Health complication	Exercise considerations	Physical activity recommendations/precautions
Foot ulcers/amputations	• Moderate walking is not likely to increase risk of foot ulcers or reulceration with peripheral neuropathy (165).	• Weight-bearing activity should be avoided with unhealed ulcers. • Examine feet daily to detect and treat blisters, sores, or ulcers early. • Amputation sites should be properly cared for daily. • Avoid jogging.
Autonomic neuropathy	• May cause postural hypotension, chronotropic incompetence, delayed gastric emptying, altered thermoregulation, and dehydration during exercise (6). • Exercise-related hypoglycemia may be harder to treat in those with gastroparesis.	• With postural hypotension, avoid activities with rapid postural or directional changes to avoid fainting or falling. • With cardiac autonomic neuropathy, obtain physician approval and possibly undergo symptom-limited exercise testing before commencing exercise (166). • With blunted heart rate response, use heart rate reserve and ratings of perceived exertion to monitor exercise intensity (167). • With autonomic neuropathy, avoid exercise in hot environments and hydrate well.

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Recommendations for exercise with health-related complications

Table 5—Physical activity consideration, precautions, and recommended activities for exercising with health-related complications

Health complication	Exercise considerations	Physical activity recommendations/precautions
Eye diseases		
Mild to moderate nonproliferative retinopathy	• Individuals with mild to moderate nonproliferative changes have limited or no risk for eye damage from physical activity.	• All activities okay with mild, but annual eye exam should be performed to monitor progression. • With moderate nonproliferative retinopathy, avoid activities that dramatically elevate blood pressure, such as powerlifting.
Severe nonproliferative and unstable proliferative retinopathy	• Individuals with unstable diabetic retinopathy are at risk for vitreous hemorrhage and retinal detachment.	• Avoid activities that dramatically elevate blood pressure, such as vigorous activity of any type. • Avoid vigorous exercise; jumping, jarring, and head-down activities; and breath holding (6). • No exercise should be undertaken during a vitreous hemorrhage.
Cataracts	• Cataracts do not impact the ability to exercise, only the safety of doing so due to loss of visual acuity.	• Avoid activities that are more dangerous due to limited vision, such as outdoor cycling. • Consider supervision for certain activities.

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Recommendations for exercise with health-related complications

Table 5—Physical activity consideration, precautions, and recommended activities for exercising with health-related complications

Health complication	Exercise considerations	Physical activity recommendations/precautions
Kidney diseases		
Microalbuminuria	• Exercise does not accelerate progression of kidney disease even though protein excretion acutely increases afterward (6,159). • Greater participation in moderate-to-vigorous leisure time activity and higher physical activity levels may actually moderate the initiation and progression of diabetic nephropathy (168–170).	• All activities okay, but vigorous exercise should be avoided the day before urine protein tests are performed to prevent false positive readings.
Overt nephropathy	• Both aerobic and resistance training improve physical function and quality of life in individuals with kidney disease. • Individuals should be encouraged to be active.	• All activities okay, but exercise should begin at a low intensity and volume if aerobic capacity and muscle function are substantially reduced.
End-stage renal disease	• Doing supervised, moderate aerobic physical activity undertaken during dialysis sessions may be beneficial and increase compliance (171).	• Exercise should begin at a low intensity and volume if aerobic capacity and muscle function are substantially reduced. • Electrolytes should be monitored when activity done during dialysis sessions.

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Recommendations for exercise with health-related complications

Table 5—Physical activity consideration, precautions, and recommended activities for exercising with health-related complications

Health complication	Exercise considerations	Physical activity recommendations/precautions
Orthopedic limitations		
Structural changes to joints	• Individuals with diabetes are more prone to structural changes to joints that can limit movement, including shoulder adhesive capsulitis, carpal tunnel syndrome, metatarsal fractures, and neuropathy-related joint disorders (Charcot foot) (25).	• In addition to engaging in other activities (as able), do regular flexibility training to maintain greater joint range of motion (10,12). • Stretch within warm-ups or after an activity to increase joint range of motion best (172). • Strengthen muscles around affected joints with resistance training. • Avoid activities that increase plantar pressures with Charcot foot changes.
Arthritis	• Common in lower-extremity joints, particularly in older adults who are overweight or obese. • Participation in regular physical activity is possible and should be encouraged. • Moderate activity may improve joint symptoms and alleviate pain.	• Most low- and moderate-intensity activities okay, but more non–weight-bearing or low-impact exercise may be undertaken to reduce stress on joints. • Do range-of-motion activities and light resistance exercise to increase strength of muscles surrounding affected joints. • Avoid activities with high risk of joint trauma, such as contact sports and ones with rapid directional changes.

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Conclusions

- Physical activity and exercise should be recommended and prescribed to all individuals with diabetes.
- Specific recommendations and precausions will vary by the type of diabetes,age,activity done,and presence of diabetes-related health complications.
- In addition to engaging in regular physical activity, all adults should be encouraged to decrease the total amount of daily sedentary time to break up sitting time with frequent bouts of activity.
- Behavior-change strategies can be used to promote the adoption and maintenance of lifetime physical activity.