Exercise for patients with diabetes

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The benefits of regular exercise in DM

- **type 1 and type 2 DM**
  - improved glucose tolerance
  - increased insulin sensitivity
  - decreased HbA_{1c}
  - decreased insulin requirements

- **type 1 and type 2 DM**
  - improvement in CVD risk factors
  - improvement in wellbeing

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Exercise prescription for diabetes

- Aerobic exercise training
  - Frequency: 3-7 d · wk
  - Intensity: 50%-80% VO2R or HRR
    rating of perceived exertion (RPE) of 12~16 on a 6~20 scale
  - Time: 20-60 min · d
    continuous or accumulated in bouts of at least 10min to total 150~300min · wk
  - Type: use large muscle groups

※ If weight loss maintanence is the goal, type 2 DM
: exercise caloric energy expenditure of ≥2,000kcal · wk

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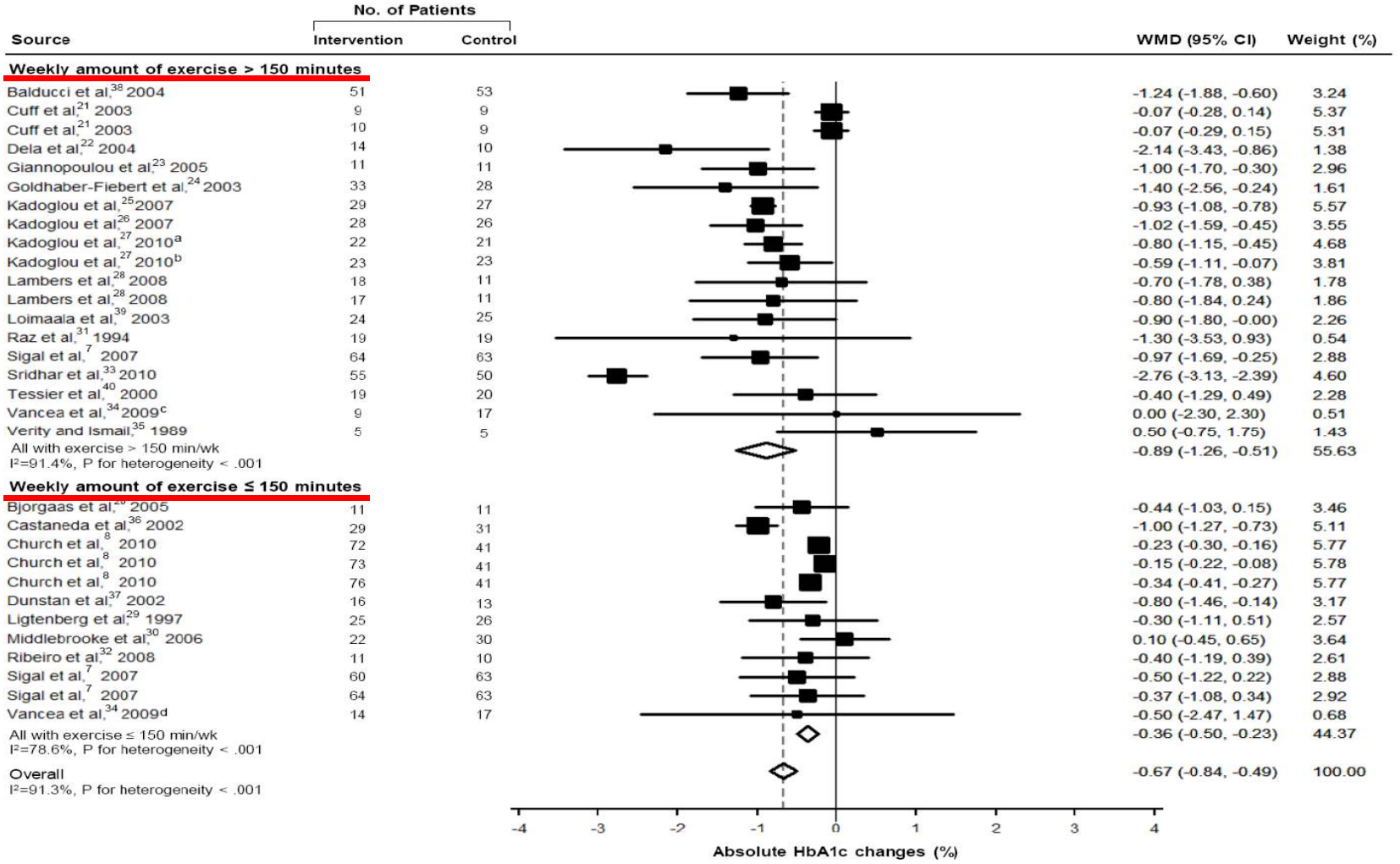
Weekly amount of exercise >150 minutes and HbA_{1c} Levels in Type 2 Diabetes: A Systematic Review and Meta-analysis



Umpierre D. et al. JAMA 2011

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Exercise prescription for diabetes

- Resistance training
  - Frequency: 2-3 d · wk
  - Intensity: 2-3 sets of 8-12repetitions at 60%-80% 1RM
  - Time: 8-10 multijoint exercises of all major muscle groups
  - Type: Type is emphasize proper technique, including minimizing sustained gripping, static work with isometric exercise, and the Valsalva maneuver to prevent an exacerbated BP response.

※ should be encouraged for people with DM in the absence of contraindications, retinopathy, and recent laser treatments.

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Exercise testing for diabetes

- DM with <10% risk of a cardiac event over a 10-year period and exercise program of low to moderate intensity

  : exercise testing may not be necessary

- DM with ≥10% risk of a cardiac event over a 10-year period and who want to begin a vigorous intensity exercise program

  (≥60% VO_2R)

  : should undergo medically supervised graded exercise test (GXT) with electrographic (ECG) monitoring

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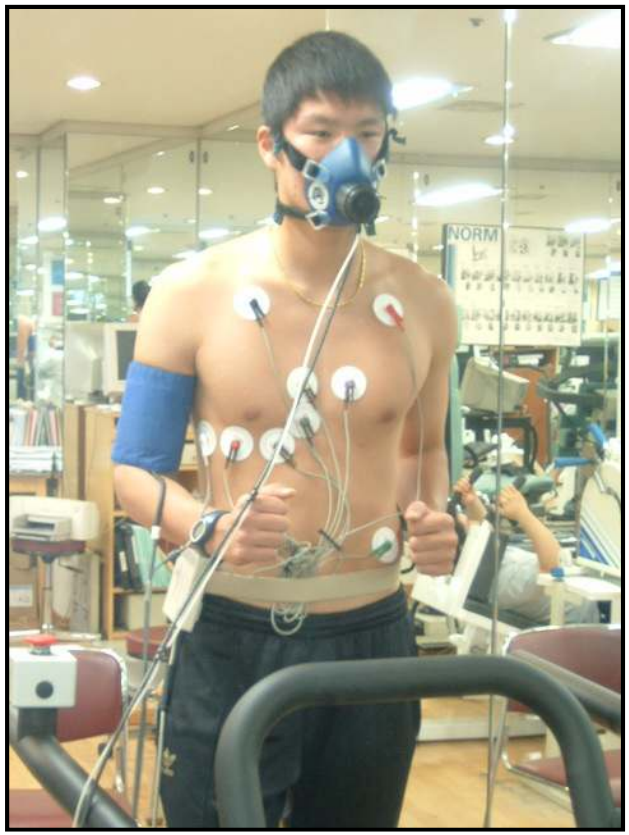
Exercise testing

- Graded exercise test(GXT)
  - PAD
  - orthopedic disabilities
- neurologic diseases: stress echocardiography
- autonomic neuropathy
  : cardiac screening, thallium scintigraphy
- to detect CVD in patients with DM often fail to detect silent ischemia

Graded exercise test(GXT)



- ECG monitoring
- VO_2max
- symptome limited
- exercise intensity

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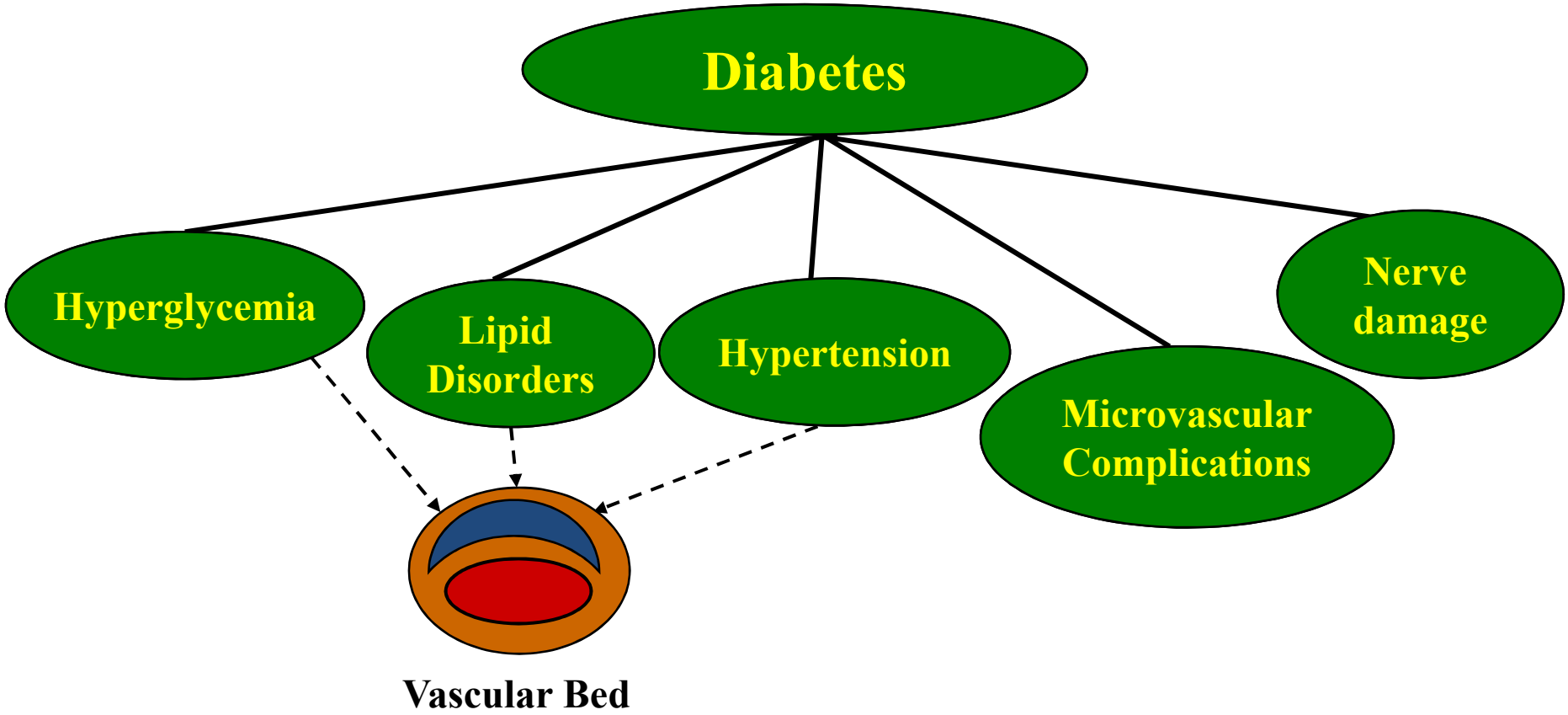
Assaults on the vascular bed in diabetes



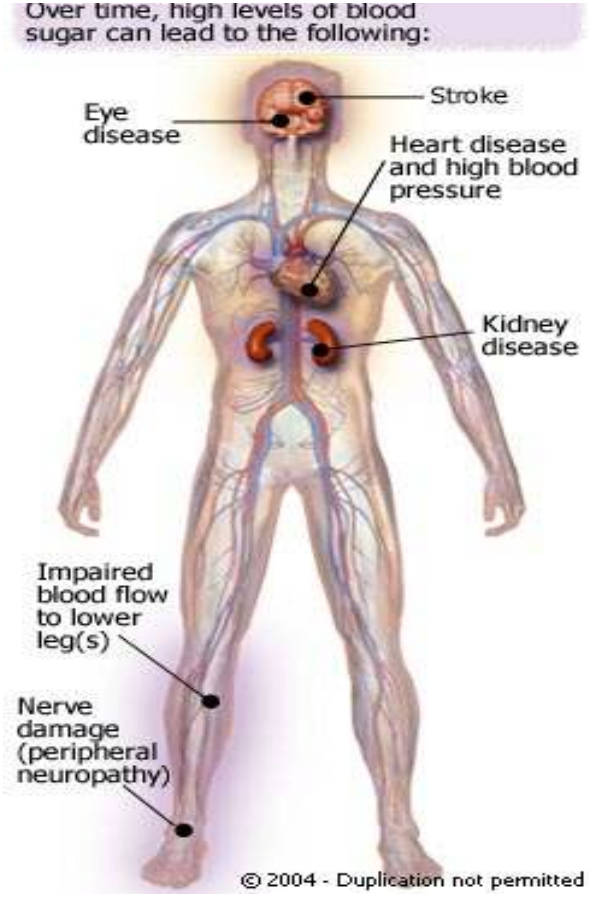
Diabetes related complications

A. Macrovascular complications

1) Hypertension
2) Lipid disorders
3) Heart disease

B. Microvascular complications

1) Diabetic retinopathy
2) Diabetic nephropathy
3) Diabetic peripheral neuropathy



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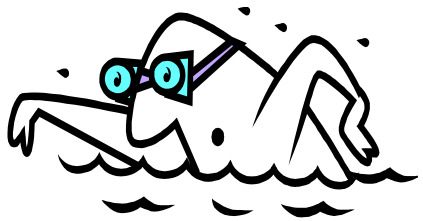
Effect of exercise

- **Lower peripheral vascular resistance**
- **Prevention of complication**
- **Body weight control**
- **Reduce stress**

Lower peripheral vascular resistance

- **Sympathetic tone(Catecholamine, renin) ↓**
- **Parasympathetic tone(Prostaglandin E) ↑**
- **Rest HR, CO ↓**
- **Coronary artery calcification ↓**
- **Blood vessel elasticity ↑**



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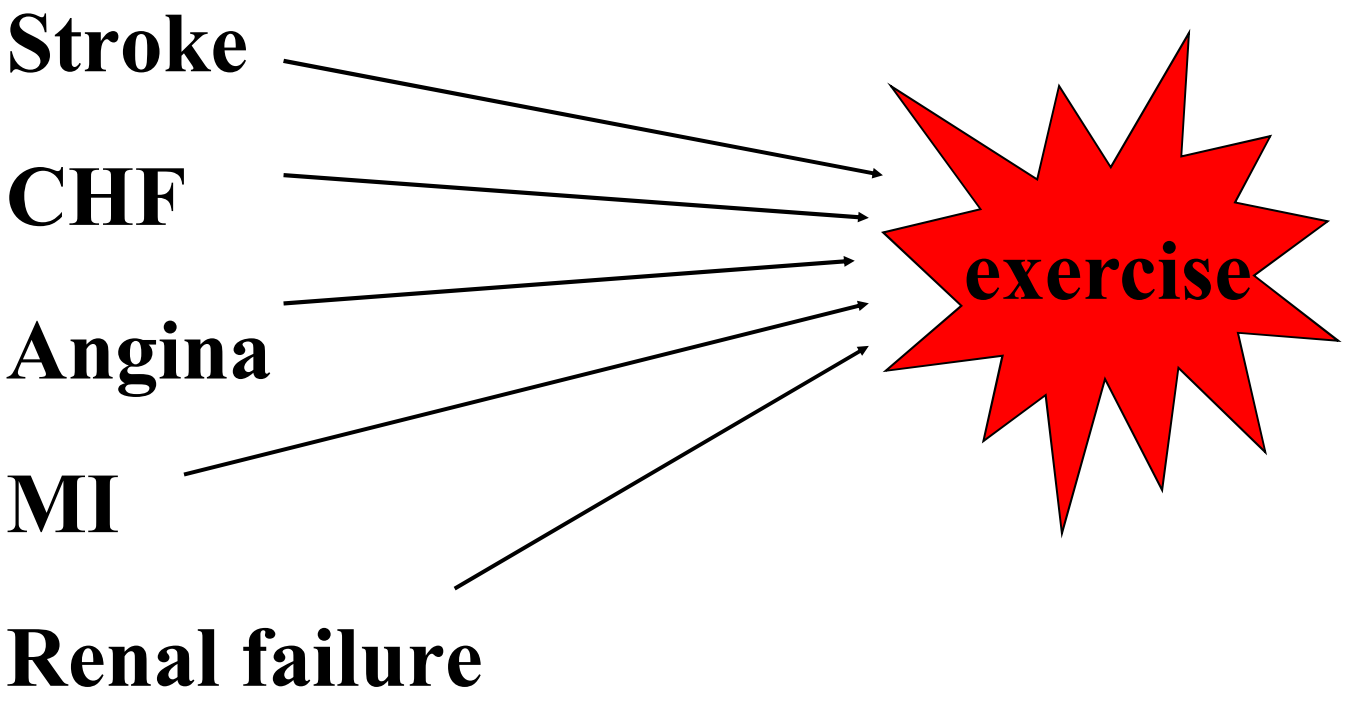
Prevention of complication



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Body weight control

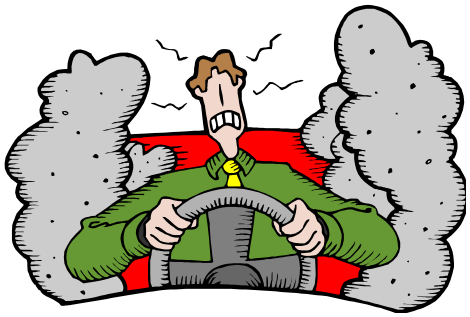
- Lose weight↓, BMI↓
- Fat mass↓, Central fat↓
- Muscle Mass↑
- Hyperinsulinemia↓
- Dopamine↑, Diuretic effect↑
- Fluid volume↓

• Body weight Vs BP

Body weight(kg)	SBP(mmHg)	DBP(mmHg)
-10	-25	-15
-5	-10	5
-2	2~3	1

Reduce stress

- **Blood catecholamine level ↓**
- **Plasma renin activity ↓**
- **Psychosocial stress ↓**
- **Confidence ↑**
- **Life quality ↑, Well-being ↑**



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Effects of Exercise on Cardiovascular Risk Factors in Type 2 Diabetes: A meta-analysis

RESULTS—Of 645 articles retrieved, 34 met our inclusion criteria; most investigated aerobic exercise alone, and 10 reported combined exercise training. Aerobic alone or combined with resistance training (RT) significantly improved HbA_{1c} −0.6 and −0.67%, respectively (95% CI −0.98 to −0.27 and −0.93 to −0.40, respectively), systolic blood pressure (SBP) −6.08 and −3.59 mmHg, respectively (95% CI −10.79 to −1.36 and −6.93 to −0.24, respectively), and triglycerides −0.3 mmol/L (95% CI −0.48 to −0.11 and −0.57 to −0.02, respectively). Waist circumference was significantly improved −3.1 cm (95% CI −10.3 to −1.2) with combined aerobic and resistance exercise, although fewer studies and more heterogeneity of the responses were observed in the latter two markers. Resistance exercise alone or combined with any other form of exercise was not found to have any significant effect on CV markers.

CONCLUSIONS—Aerobic exercise alone or combined with RT improves glycemic control, SBP, triglycerides, and waist circumference. The impact of resistance exercise alone on CV risk markers in type 2 diabetes remains unclear.

Diabetes Care 34:1228–1237, 2011

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Diabetes patient with hypertension

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Aerobic exercise

- **JNC6, ACSM6**

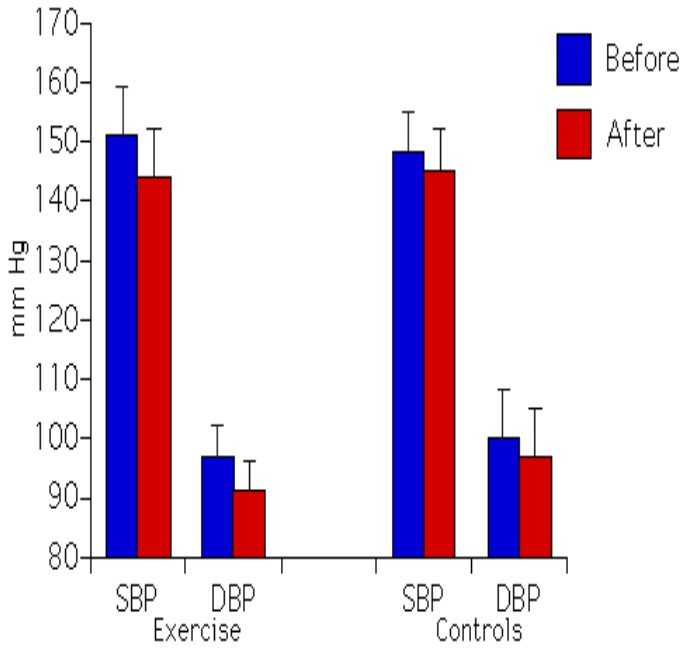
  aerobic exercise > physical activity

- **JNC7, ACSM7**

  aerobic exercise = physical activity

- **JNC8, ACSM8**

  aerobic exercise < physical activity



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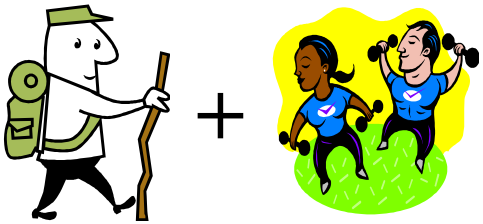
Exercise Type



- **Aerobic exercise**
- **Resistance exercise**
- **Combine exercise**

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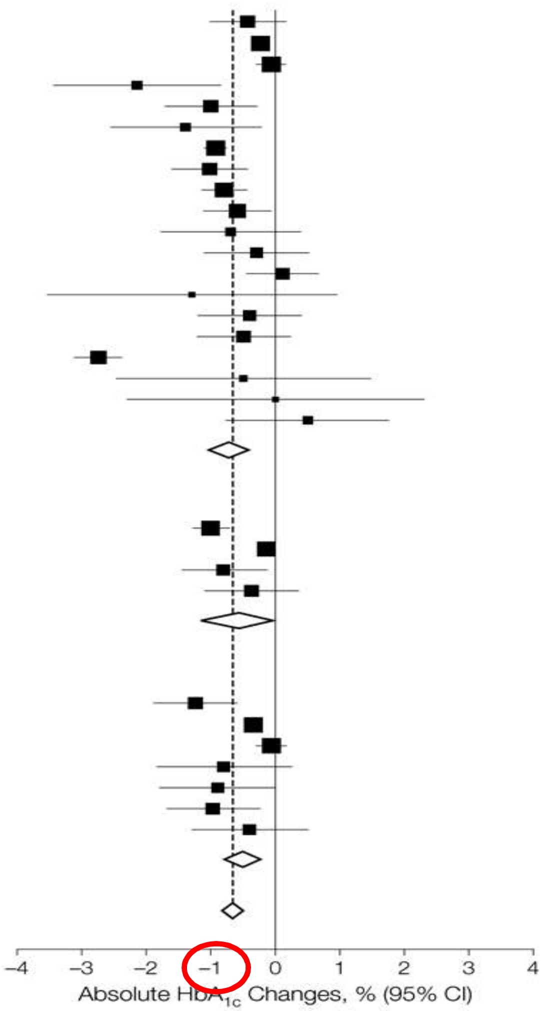
Aerobic Training, Resistance training, Combined training and HbA_{1c} Levels in Type 2 Diabetes: A Systematic Review and Meta-analysis

Source	No. of Patients: Intervention	No. of Patients: Control	HbA_{1c} Weighted Mean Difference, % (95% CI)	Weight, %
Aerobic training				
Bjørgaas et al,[20] 2005	11	11	−0.44 (−1.03 to 0.15)	3.46
Church et al,[8] 2010	72	41	−0.23 (−0.30 to −0.16)	5.77
Cuff et al,[21] 2003	9	9	−0.07 (−0.28 to 0.14)	5.37
Dela et al,[22] 2004	14	10	−2.14 (−3.43 to −0.86)	1.38
Giannopoulou et al,[23] 2005	11	11	−1.00 (−1.70 to −0.30)	2.96
Goldhaber-Fiebert et al,[24] 2003	33	28	−1.40 (−2.56 to −0.24)	1.61
Kadoglou et al,[25] 2007	29	27	−0.93 (−1.08 to −0.78)	5.57
Kadoglou et al,[26] 2007	28	26	−1.02 (−1.59 to −0.45)	3.55
Kadoglou et al,[27] 2010[a]	22	21	−0.80 (−1.15 to −0.45)	4.68
Kadoglou et al,[27] 2010[b]	23	23	−0.59 (−1.11 to −0.07)	3.81
Lambers et al,[28] 2008	18	11	−0.70 (−1.78 to 0.38)	1.78
Ligtenberg al,[29] 1997	25	26	−0.30 (−1.11 to 0.51)	2.57
Middlebrooke et al,[30] 2006	22	30	0.10 (−0.45 to −0.65)	3.64
Raz et al,[31] 1994	19	19	−0.30 (−3.53 to 0.93)	0.54
Ribeiro et al,[32] 2008	11	10	−0.40 (−1.19 to 0.39)	2.61
Sigal et al,[7] 2007	60	63	−0.50 (−1.22 to 0.22)	2.88
Sridhar et al,[33] 2010	55	50	−2.76 (−3.13 to −2.39)	4.60
Vancea et al,[34] 2009[c]	14	17	−0.50 (−2.47 to 1.47)	0.68
Vancea et al,[34] 2009[d]	9	17	0.00 (−2.30 to 2.30)	0.51
Verity and Ismail,[35] 1989	5	5	0.50 (−0.75 to 1.75)	1.43
All aerobic training I^2 = 92.8%; *P* for heterogeneity <.001			−0.73 (−1.06 to −0.40)	59.41
Resistance training				
Castaneda et al,[36] 2002	29	31	−1.00 (−1.27 to −0.73)	5.11
Church et al,[8] 2010	73	41	−0.15 (−0.22 to −0.08)	5.78
Dunstan et al,[37] 2002	16	13	−0.80 (−1.46 to −0.14)	3.17
Sigal et al,[7] 2007	64	63	−0.37 (−1.08 to 0.34)	2.92
All resistance training I^2 = 92.5%; *P* for heterogeneity <.001			−0.57 (−1.14 to −0.01)	16.68
Combined training				
Balducci et al,[38] 2004	51	53	−1.24 (−1.88 to 0.60)	3.24
Church et al,[8] 2010	76	41	−0.34 (−0.41 to −0.27)	5.77
Cuff et al,[26] 2003	10	9	−0.07 (−0.29 to 0.15)	5.31
Lambers et al,[28] 2008	17	11	−0.80 (−1.84 to 0.24)	1.86
Loimaala et al,[39] 2003	24	25	−0.90 (−1.80 to −0.00)	2.26
Sigal et al,[7] 2007	64	63	−0.97 (−1.69 to −0.25)	2.86
Tessier et al,[40] 2000	19	20	−0.40 (−1.29 to 0.49)	2.28
All combined training I^2 = 67.5%; *P* for heterogeneity = .005			−0.51 (−0.79 to −0.23)	23.61
Overall I^2 = 91.3%; *P* for heterogeneity <.001			−0.67 (−0.84 to −0.49)	100.00



Umpierre D. et al. JAMA 2011

Resistance exercise(ACSM8)

- **Resistance exercise produces the most striking increases in BP.**
- **less of a HR increase compared with aerobic exercise.**
- **Total myocardial burden may be less than aerobic exercise.**

Exercise prescription for diabetes patient with hypertension

exercise test	exercise prescription	Exercise considerations
• Exercise test - GXT - physical fitness test • Medication take for taking time • Observation of inflated BP response (>250/>115mmHg)	• Aerobic exercise - frequency: all days/wk - duration: 30-60min/d - intensity: 40-60% VO2R i.e., ≥60% VO2R: medically supervised symptom-limited GXT SBP ≤180/110mmHg - type: use large muscle groups • Resistance exercise - frequency: 2~3rep/wk - intensity: 60-80%1RM - duration: 8~12rep/1~3set - type: 8-10,major muscle groups	• Resting BP, >200/>110mmHg: do not Ex. after medication treatment 40-60% VO2R • Diuretics: decrease K^+, arrhythmia ↑ • Diuretics and B-blockers : adversely affect thermoregulatory function and cause hypoglycemia • Vasodilator post-exercise hypotension ↑ : proper cool-down • Resistance exercise : be careful Valsalva maneuver

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Consequence of warm-up & cool-down

Warm-up

- **Transition form Rest to Exercise**
  - **Stretch postural muscles**
  - **Blood flow↑**
  - **Metabolic rate↑**
- **Reduce Musculoskeletal Injury**
  - **C.T. extensibility↑**
  - **Improve Joint ROM and Function**
- **Prevent Cardiovascular Events**

Cool-down

- **Appropriate Circulatory adjustment**
- **Return of HR and BP**
- **Enhance Venous return**
- **Postexercise Hypotension or Dizziness↓**
- **Dissipation of Body Heat↑**
- **Removal of Lactic acid↑**
- **Postexercise Catecholamine effect↓**

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Diabetes patient with dyslipidemia

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Definition of dyslipidemia

- **genetic, environmental, Pathological changes**

  : TC, TG, LDL .... abnormal increase → atherosclerosis ↑

- **comorbidity(DM, Obesity, atherosclerosis ..) + gene + environment ↑**
- **dyslipidemia patients**

  : even if exercise steadily improving cholesterol are few and far between

- **exercise: control the other cardiovascular risk factors ↑**
- **healthy lifestyle is important**

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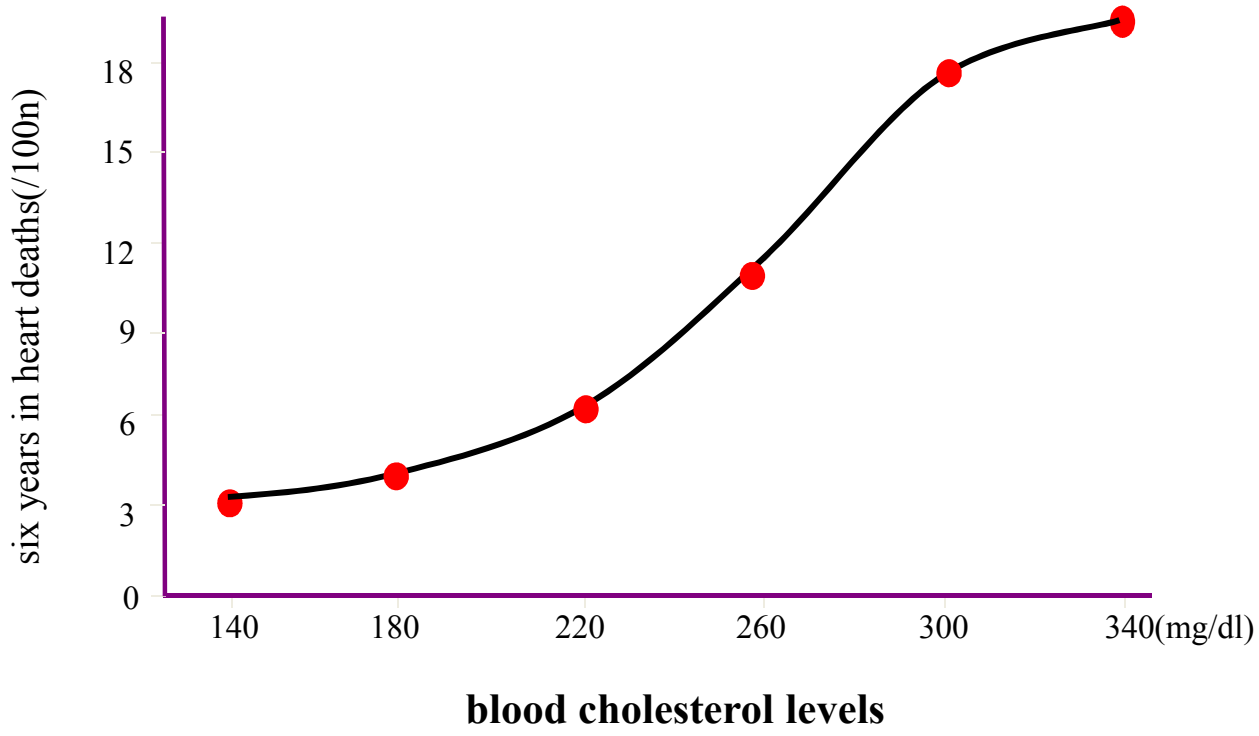
Heart deaths according to blood cholesterol levels



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Effect of exercise

↓ TC, TG, LDL-C
↑ FFA, HDL-C
↓ hs-CRP
↑ LPL(lipoprotein lipase)
↓ HTGL(hepatic triglyceride lipase]
↓ Platelet aggregation
↓ progression of disease
↓ Medications
↓ Anxiety and Depression

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Exercise testing

- **pre- test: classification of risk**
- **caution of exercise test: basis of CVD**
- **using standard Exercise test, protocol**
- **comorbidity(HTN, obesity...): GXT protocol modification**
- **xanthoma: alternative test**

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Exercise considerations

- **take statin, exercise specific muscle pain**
  : councle with a physician
- **aerobic exercise, in effect a few months unrest**
  : must exercise more than six months
  (blood cholesterol, lipoprotein, energe expenditure, goal exercise)
- **resistance exercise: start after six months**

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Diabetes patient with cardiac disease

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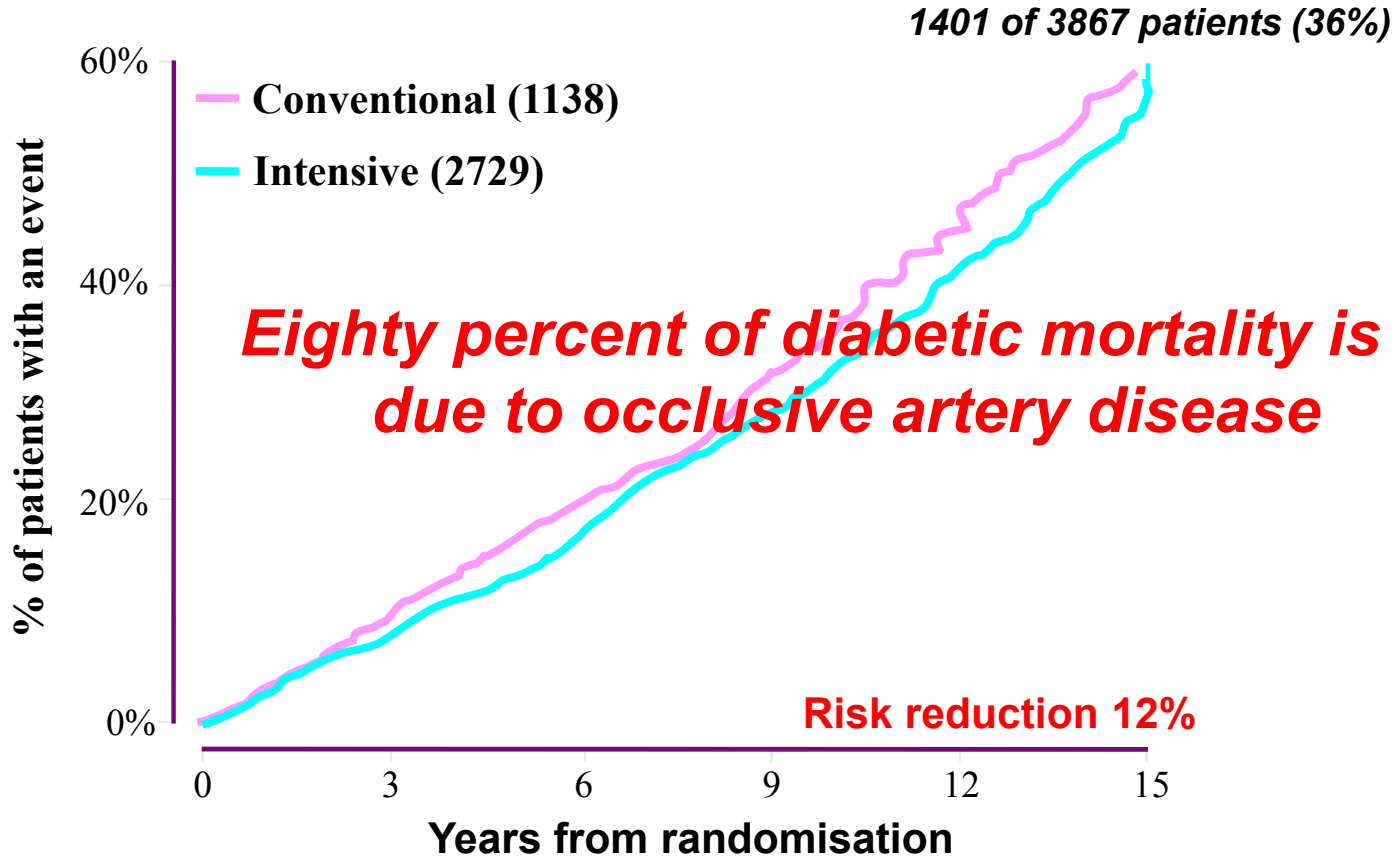
Diabetes and cardiac disease



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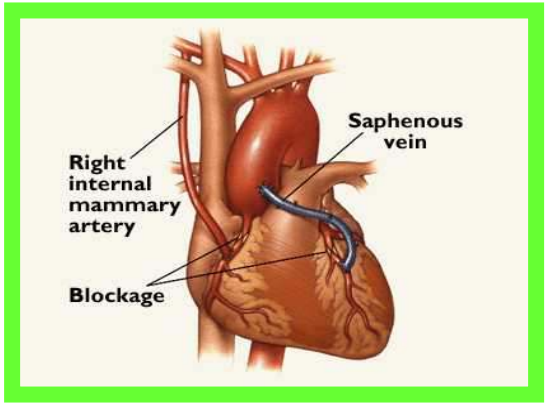
Turner et al. UKPDS 23. *BMJ* 1998:316:823-828

Subject of cardiac rehabilitation

- **MI**
- **CABG**
- **PTCA**
- **Angina**
- **Cardiomyopathy**
- **CHF**
- **Heart transplantation**
- **Valvular disease**
- **HTN**
- **Pacemaker**

Beginning of exercise

- **medication: starting tomorrow**
- **balloon angioplasty: starting after week**
- **STENT: starting after 3 weeks**
- **CABG: starting after 8 weeks**



- **previous activity : light ADL**

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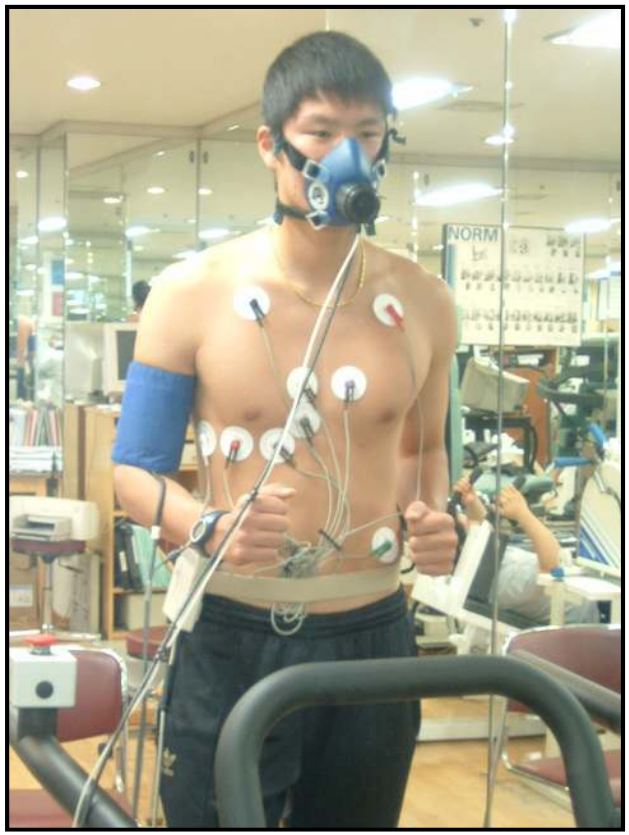
Graded exercise test(GXT)



- ECG monitoring
- VO_2max
- symptome limited
- exercise intensity

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BIA & circumference

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Exercise counseling

- exercise prescription
- exercise management
- risk factor management

- exercise place
  - SMC exercise
  - Home-based exercise

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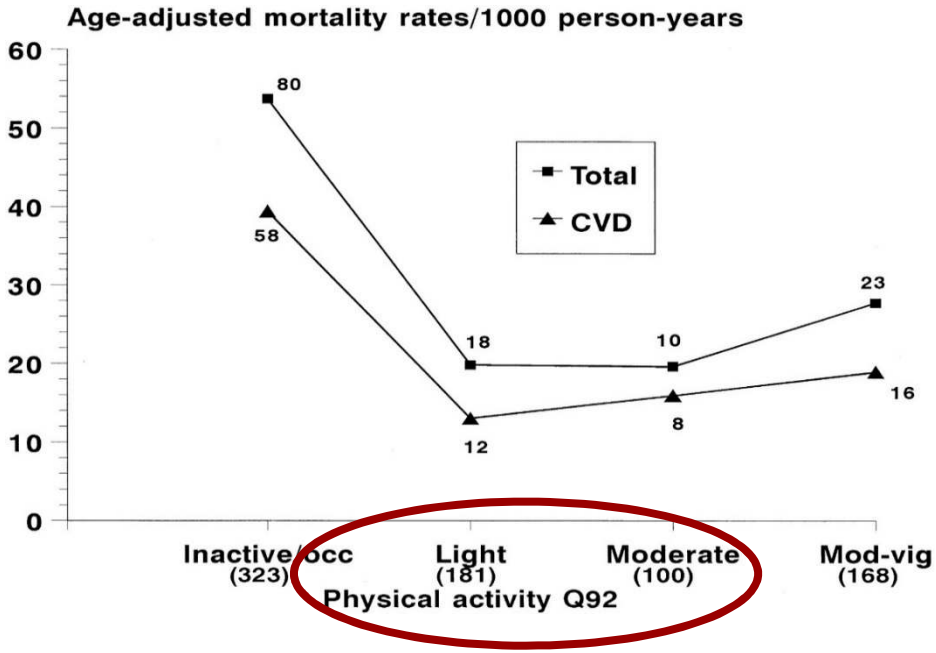
Exercise evidence: Mortality risk

Observational study of self-reported physical activity in 772 men with established coronary heart disease



Light or moderate exercise is associated with lower risk

Wannamethee SG et al. *Circulation* 2000;102:1358-1363

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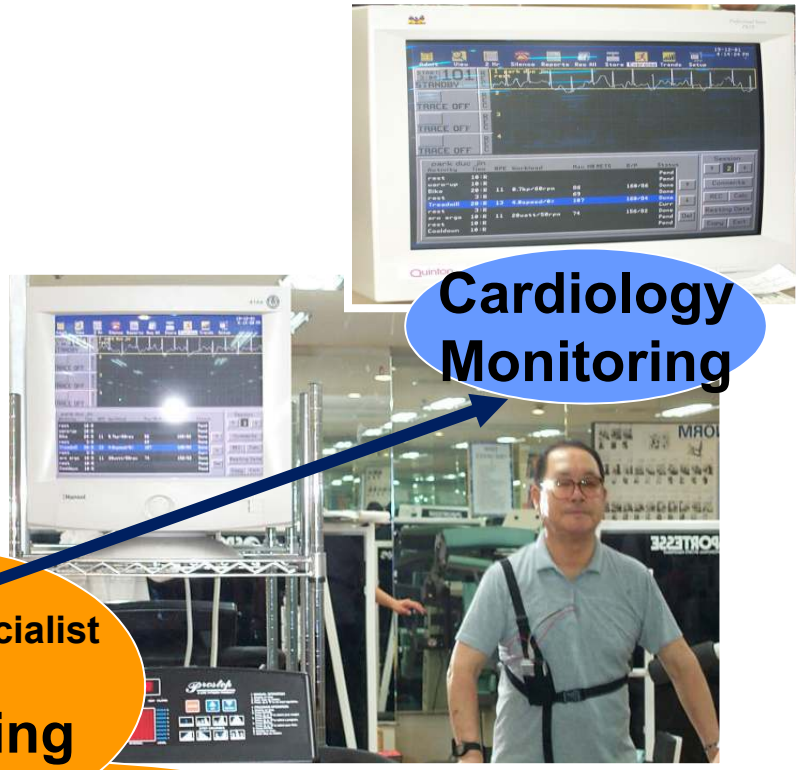
Cardiac rehabilitation program



Cardiology Monitoring

Exercise Specialist Nurse Monitoring

Exercise track

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Cardiac rehabilitation program

Phase of cardiac rehabilitation program

- Phase 1: inpatient
- Phase 2: outpatient 12wks

  medically supervised exercise, ECG monitoring
- Phase 3: medically supervised exercise, No ECG monitoring
- Phase 4: No supervised exercise, No ECG monitoring - home exercise

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Exercise prescription criteria

1. Low-risk

① LV function: EF >50%

② resting, exercising: No arrhythmia

③ stable MI: CABG; percutaneous coronary intervention(PCI)

④ exercising, recovery: normal BP response

⑤ resting, exercising: No chest pain

⑦ >7METs

2. Moderate-risk

① LV function: EF = 40-49%

② 5-6.9METs,

③ recovery: angina sign, symptom

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Exercise prescription criteria

3. High-risk

① LV function: EF <40%

② history: cardiac arrest, sudden death survivor

③ unstable ventricle arrhythmia

④ exercising hypotension (SBP:decrease ≥15mmHg)

⑥ <5METs exercising, recovery: angina sign, symptom

⑦ <5METs

Exercise prescription for diabetes patient with cardiac disease

- **Aerobic exercise training**
  - **Frequency:** 5-7 d · wk
  - **Intensity:** 40% VO2R
    rating of perceived exertion (RPE) of 11~13 on a 6~20 scale
  - **Time:** 20-60 min · d
    continuous or accumulated in bouts of at least 3~10min x 6~10set
  - **Type:** use large muscle groups
    e.g. cycle ergometer, treadmill, stepper, cyclerun…

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Exercise prescription for diabetes

- **Resistance training**
  - **Frequency:** 2-3 d · wk
  - **Intensity:** upper extremity 30%-40%1RM
    lower extremity 50%-60%1RM,
    1-2sets of 12-15repetitions, RPE of 11~13
    low-risk patients: 8-12repetitions at 60%-80%1RM
  - **Time:** 8-10 multijoint exercises of all major muscle groups
  - **Type:** thera-band, ball, free weight, weight machine…
    Valsalva maneuver to prevent an exacerbated BP response.

Diabetic retinopathy

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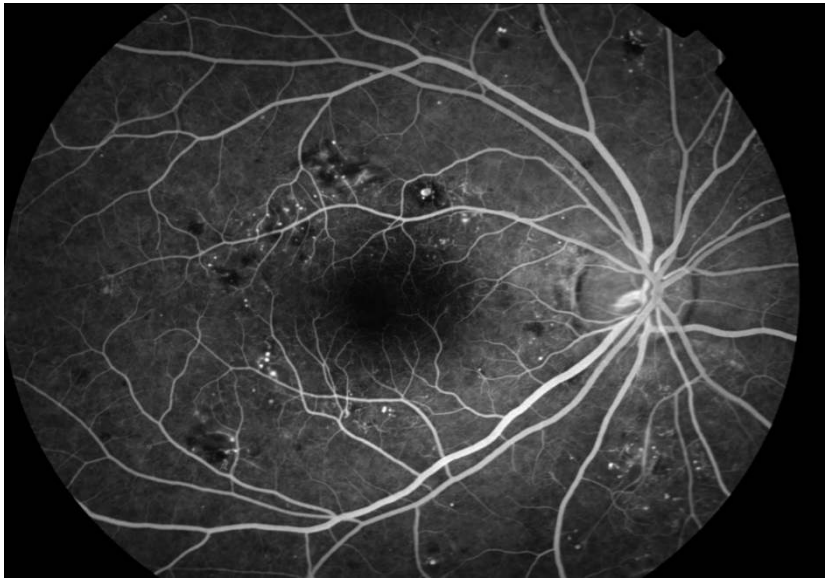
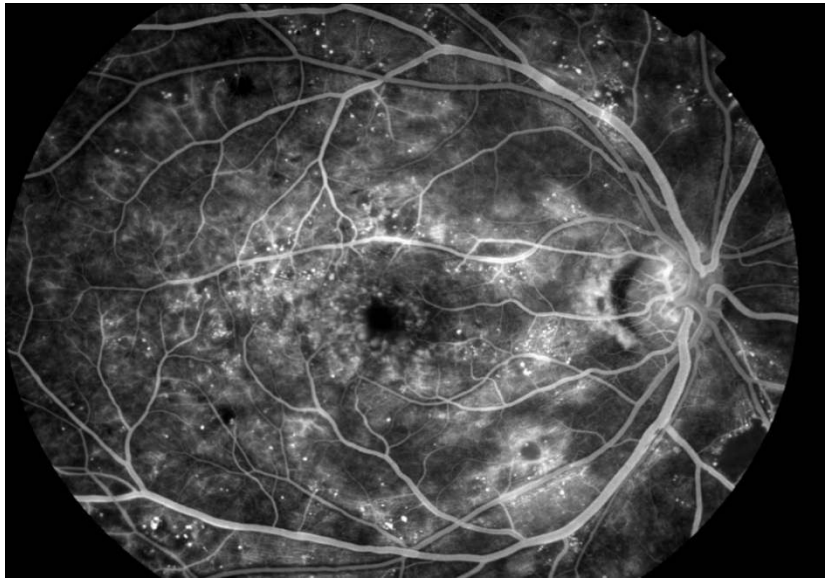
Retinopathy test



: No symptoms

One year after refusing treatment



: deteriorate eyesight → loss of sight

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Risk factor of retinopathy

- duration of diabetes
- degree of regulation of blood glucose
- hypertention
- dyslipidemia
- kidney disease
- gene

Normal vision

Vision with diabetic retinopathy

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Exercise considerations

- **≥80%1RM, high-intensity weight training (x)**
- **upper body weight training: <50%1RM or skip**
- **be careful Valsalva maneuver**
- **skin scuba, marathon, exercise that hold head down (x)**
- **proliferative retinopathy**

  : Adequate remedy then start exercise

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Diabetic nephropathy

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Diabetic nephropathy

- **Characteristics**
  - **continuous albuminuria**
  - **BP↑**
  - **Glomerular filtration rate ↓**
  - **Cardiovascular mortality ↑**
  - **Chronic renal failure**
- **10~15 years after diabetes**

  1.initial stage – microscopic albuminuria(recoverable)

  2. ≠ overt proteinuria (irreparable)

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Risk factor of nephropathy

- **A1c > Upper limit of normal 2 %**
- **Family history of Diabetic nephropathy**
- **smoking**
- **duration of diabetes > 5years**
- **Family history of hypertension, dyslipidemia**

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Exercise considerations

- **30% of patients with diabetes were a diabetic nephropathy**
- **severe diabetic nephropathy: GXT**

  high-risk CAD, abnomal HR, BP response ↑
- **exercise that increases BP: micro-albuminuria ↑**
- **aerobic + resistance Ex.(combine): physical activity, QOL ↑**
- **resistance Ex.: muscle strengthening, ADL ↑**

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Exercise considerations

- **long periods of high-intensity aerobic exercise (x)**
- **low intensity resistance exercise**

  : thera-band, ball, dumbbell(1~2kg)
- **protein supplements (x)**
- **excessive coffee, water, iron beverages intake limit**

Diabetic peripheral neuropathy

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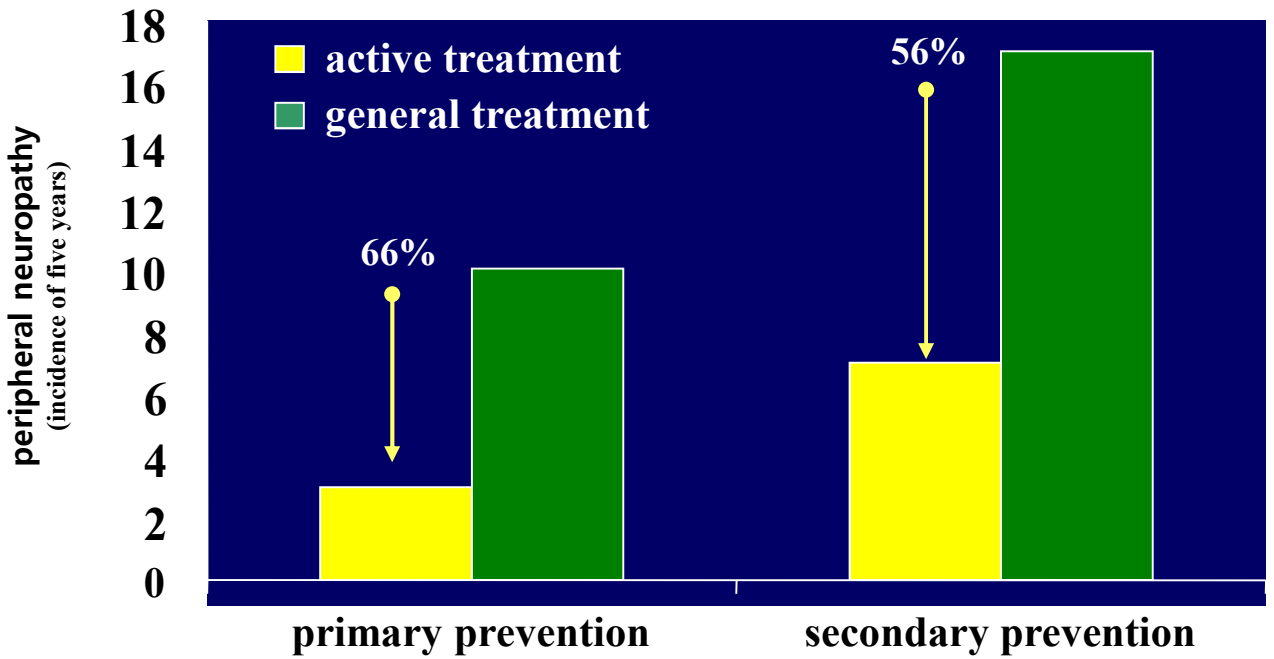
Controlling blood sugar and diabetic peripheral neuropathy



DCCT Study Group. *N Engl J Med* 329:977, 2003

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Foot disease

skin change

- drying, pachylosis, cracks
- dry foot after a bath - moisturizer
- between the toes not to apply the oils on

callus

- increase the frequency than normal
- neglect: change an ulcer
- chemical solvent, such as removal should not try
- treatment: medical team

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Exercise considerations

- **caution: long-time weight bearing exercise**
- **profer: Non weight bearing exercise- Cycle ergometer(0), swimming(?)**
- **resting time between exercise**
- **gym shoes**

  : comfortable, shock-absorbing, wear socks, barefoot walk prohibition
- **after exercising, taking care of your feet**

  : cleanliness, drying toes, claw control
- **medical treatment: After exercising, feet infection, inflammation, wound**

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Elderly diabetes patient

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Exercise prescription for elderly diabetes patient

- **Aerobic Activity**
  - **Frequency:** 5~ d · wk
  - **Intensity:** 50%-60%VO2R, 3~6METs
    moderate (5~6) intensity on a scale of 0~10
  - **Time:** 30-60 min · d
    continuous or accumulated in bouts of at least 10min to total 150~300min · wk
  - **Type:** dose not impose excessive orthopedic stress
    e.g. Aquatic exercise, stationary-cycle exercise, limited tolerance for weight bearing exercise

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Exercise prescription for elderly diabetes patient

- **Muscle strengthening Activity**
  - **Frequency**: least 2d · wk
  - **Intensity:** moderate (5~6) intensity on a scale of 0~10
    pain scale(VAS): 1~10 for level of 3
  - **Type:** progressive weight-training or weight bearing exercise
    major muscle groups of 10-15 repetitions each
    e.g. stair climbing, strengthening activities that major muscle groups

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Exercise prescription for elderly diabetes patient

- **Flexibility Activity**
  - **Frequency:** least 2 d · wk
  - **Intensity:** moderate (5~6) intensity on a scale of 0~10
    pain scale(VAS): 1~10 for level of 3
  - **Type:** any activities that maintain or increase flexibility using sustained stretches and static rather than ballistic movements

- **Balance exercise for fallers**
  - **Frequency:** 2~3 d · wk
  - **Intensity:** moderate (5~6) intensity on a scale of 0~10
  - **Type:** neuromuscular training, combines balance, agility and proprioceptive training is effective in reducing and preventing falls
    e.g. heel stands and toe stands, one legged standing with eyes open, closed, taichi, tandem walk…

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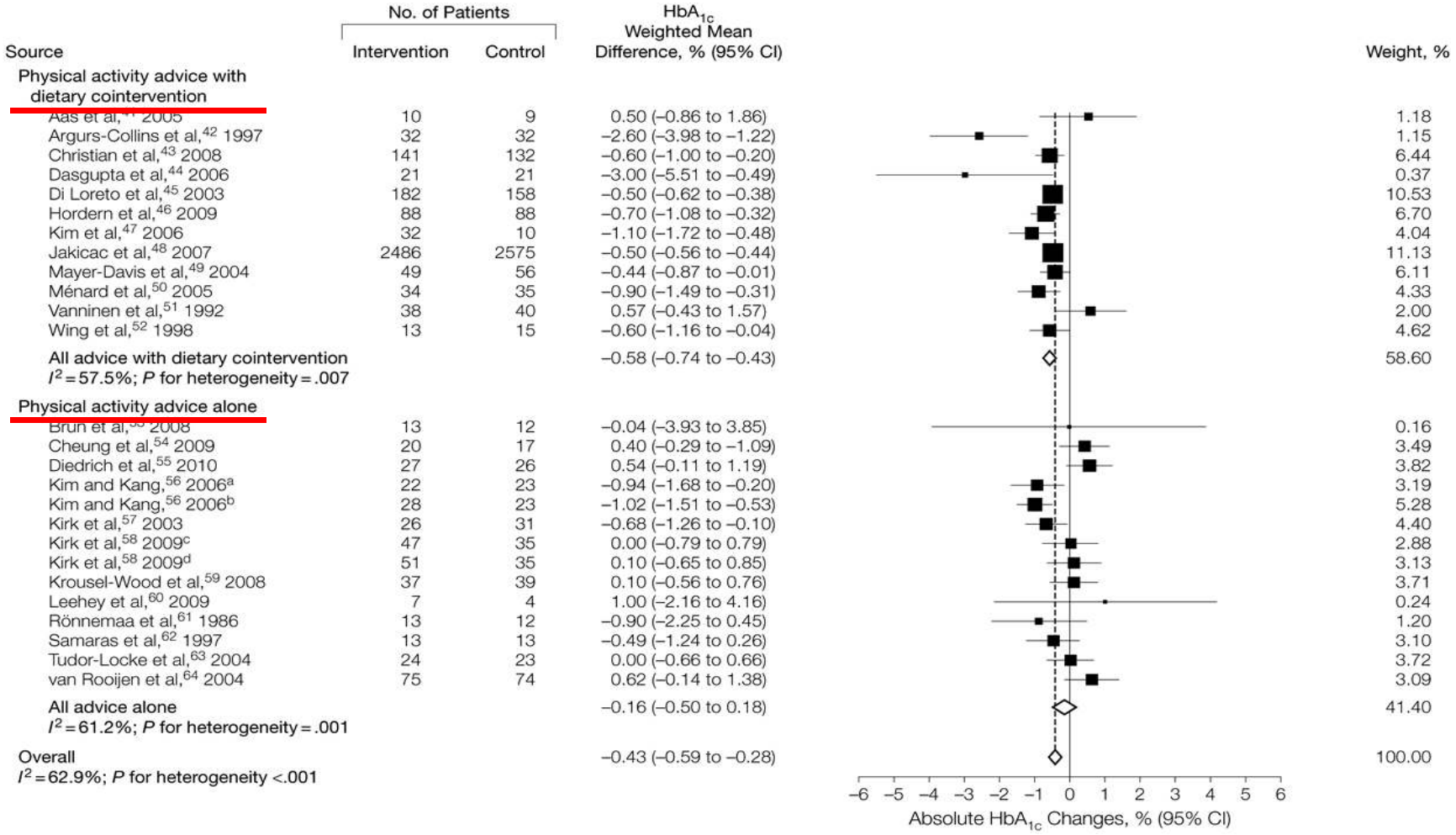
Exercise considerations

- In the early stages of an exercise program, muscle-strengthening activities may need to precede aerobic-training activities among very frail individuals.
- Strength training involving use of weight-lifting machine, initial training sessions should be supervised and monitored by personal trainer
- elderly diabetes patients should consider exceding the recommend minimum amounts of physical activity to improve management of chronic conditions…

Physical Activity Advice Only or Structured Exercise Training and Association With HbA_{1c} Levels in Type 2 Diabetes
A Systematic Review and Meta-analysis



Umpierre D. et al. JAMA 2011

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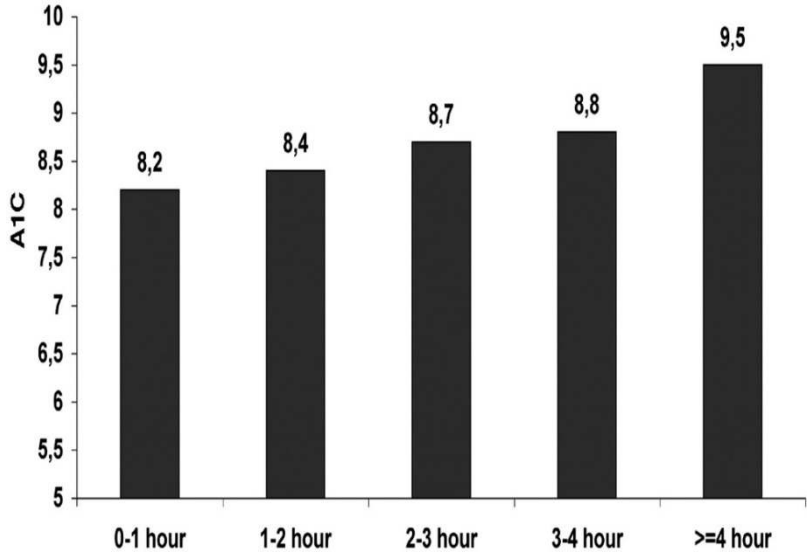
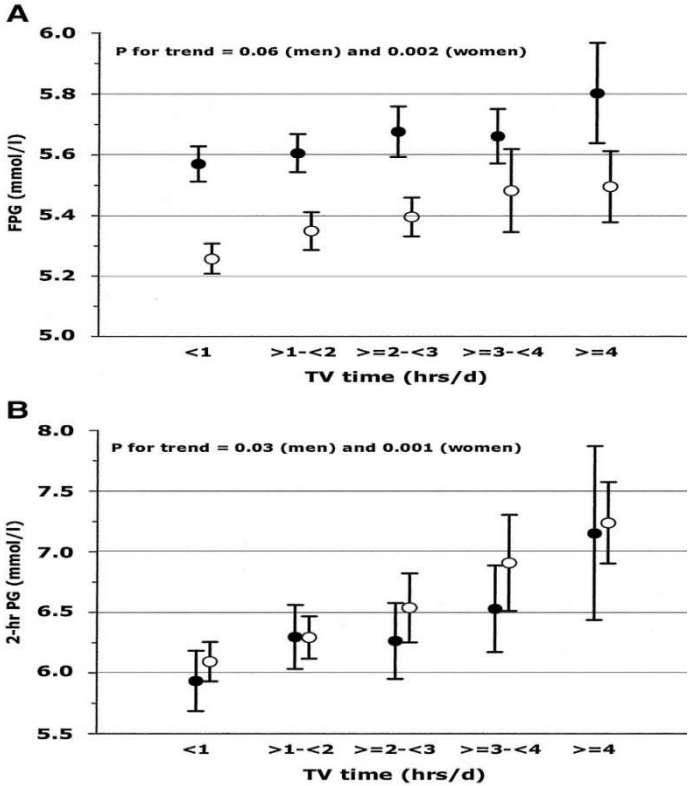
Sedentary lifestyle time and blood glucose control

Relationship between hours of watching television and A1C in type 1 diabetes



Hargeirsodottir HD et al. Diabetes Care 2007

Age-adjusted means (95% CI) for fasting plasma glucose (*A*) and 2-h PG (*B*) according to TV watching categories in men (•) and women (○)



Dunstan DW et al. Diabetes care 2007

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Supervised aerobic and resistance exercise improves glycemic control and modifiable cardiovascular risk factors in people with Type 2 diabetes mellitus

Table 1. Volume of Physical Activity (PA), Fitness, Anthropometric, and Biochemical Parameters and Medications at Baseline and at the End of the 12-Month Study Period[a]

Variable	CON Baseline	CON 12 mo	*P* Value, 0-12 mo[b]	EXE Baseline	EXE 12 mo	*P* Value, 0-12 mo[b]	Mean Difference (95% CI)	*P* Value, EXE vs CON[c]
Nonsupervised PA, MET-h/wk								
Conditioning	0.76 (1.5)	10.0 (8.7)	<.001	0.73 (1.8)	12.5 (7.4)	<.001	2.47 (1.1 to 3.8)	<.001
Nonconditioning	NA	6.7 (4.2)	NA	NA	6.6 (3.8)	NA	−0.16 (−0.82 to 0.50)	.60
Supervised PA, MET-h/wk	NA	NA	NA	NA	7.6 (2.8)	NA	NA	NA
Total PA, MET-h/wk[d]	0.76 (1.5)	10.0 (8.7)	<.001	0.73 (1.8)	20.0 (9.0)	<.001	10.0 (8.6 to 11.5)	<.001
Estimated &Vdot;O_{2max}, mL/kg/min	25.9 (7.0)	27.5 (6.8)	<.001	25.9 (5.4)	30.4 (5.8)	<.001	2.8 (2.1 to 3.5)	<.001
Upper body strength, kg	39.7 (15.7)	39.1 (15.6)	.94	40.2 (16.3)	51.0 (19.0)	<.001	11.0 (9.5 to 12.5)	<.001
Lower body strength, kg	104.0 (69.5)	102.3 (65.9)	.12	108.0 (64.5)	139.8 (72.8)	<.001	30.8 (25.1 to 35.6)	<.001
Bending, cm	11.2 (9.6)	10.1 (10.3)	<.001	12.5 (9.9)	6.7 (9.4)	<.001	−4.6 (−5.7 to −3.6)	<.001
HbA_{1c}, %	7.15 (1.4)	7.02 (1.2)	.48	7.12 (1.4)	6.70 (1.1)	<.001	−0.30 (−0.49 to −0.10)	<.001
Fasting blood glucose, mg/dL	150 (52)	140 (47)	.005	145 (49)	135 (42)	<.001	−0.68 (−9.4 to 8.1)	.88
Serum insulin, μU/mL	12.8 (8.6)	12.9 (6.9)	.06	12.4 (8.1)	11.3 (7.4)	.001	−1.18 (−2.36 to 0.0)	<.001
HOMA-IR	4.8 (3.9)	4.5 (3.1)	.29	4.5 (3.6)	3.8 (2.9)	<.001	−0.36 (−0.94 to 0.22)	.047
SBP, mm Hg	142 (18)	138 (16)	.001	140 (18)	132 (14)	<.001	−4.2 (−6.9 to −1.6)	.002
DBP, mm Hg	85 (10)	83 (9)	.02	84 (10)	80 (8)	<.001	−1.7 (−3.3 to −1.1)	.03
TG, mg/dL	139 (81)	141 (74)	.11	131 (97)	132 (82)	.20	−6.7 (−14.4 to 11.8)	.85
TC, mg/dL	201 (34)	188 (36)	<.001	199 (32)	181 (35)	<.001	−5.3 (−12.0 to 1.4)	.12
HDL-C, mg/dL	45.8 (10.5)	45.6 (10.0)	.65	44.9 (11.4)	48.4 (11.9)	<.001	3.7 (2.2 to 5.3)	<.001
LDL-C, mg/dL	128 (34)	114 (33)	<.001	129 (31)	106 (29)	<.001	−9.6 (−15.9 to −3.3)	.003
Waist circumference, cm	105.1 (11.0)	104.8 (10.9)	.04	105.2 (11.8)	101.3 (11.4)	<.001	−3.6 (−4.4 to −2.9)	<.001
BMI	31.9 (4.6)	31.7 (4.5)	.20	31.2 (4.6)	30.3 (4.4)	<.001	−0.78 (−1.07 to −0.49)	<.001
hs-CRP, mg/L	2.6 (2.0)	2.8 (2.2)	.20	2.8 (2.2)	2.0 (1.9)	<.001	−1.0 (−1.4 to −0.7)	<.001
10-y CHD UKPDS risk score	18.5 (12.2)	17.8 (12.0)	.08	19.5 (13.3)	15.8 (10.4)	<.001	−3.1 (−4.2 to −2.0)	<.001
10-y fatal CHD UKPDS risk score	12.1 (10.3)	11.9 (10.2)	.82	12.8 (11.1)	10.2 (8.5)	<.001	−2.4 (−3.3 to −1.5)	.01
Diet alone, No. (%)	22 (8.0)	18 (6.5)	.13	25 (8.7)	21 (7.3)	.22		.85

Balducci, S. et al. Arch Intern Med 2010

Conclusion

- Increase diabetes related complications
- Lifestyle improvement to the prevention and management of diabetes complications
- In any long-term Regular exercise in health care, improving the quality of life

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