

Perché consigliare l'attività fisica al soggetto diabetico?

- Migliora il controllo glicemico
- Migliora il profilo cardiovascolare
- Riduce l'incidenza delle complicanze croniche
- Migliora l'aspettativa di vita
- Migliora il senso di benessere psico-fisico

Effetti favorevoli dell'esercizio fisico sui fattori di rischio cardiovascolare nel diabete tipo 2

- Riduzione glicemia
- Aumento sensibilità insulinica
- Riduzione colesterolo LDL e trigliceridi
- Aumento colesterolo HDL
- Riduzione tessuto adiposo, specie viscerale
- Riduzione fattori trombofilici
- Controllo dell'ipertensione (lieve)

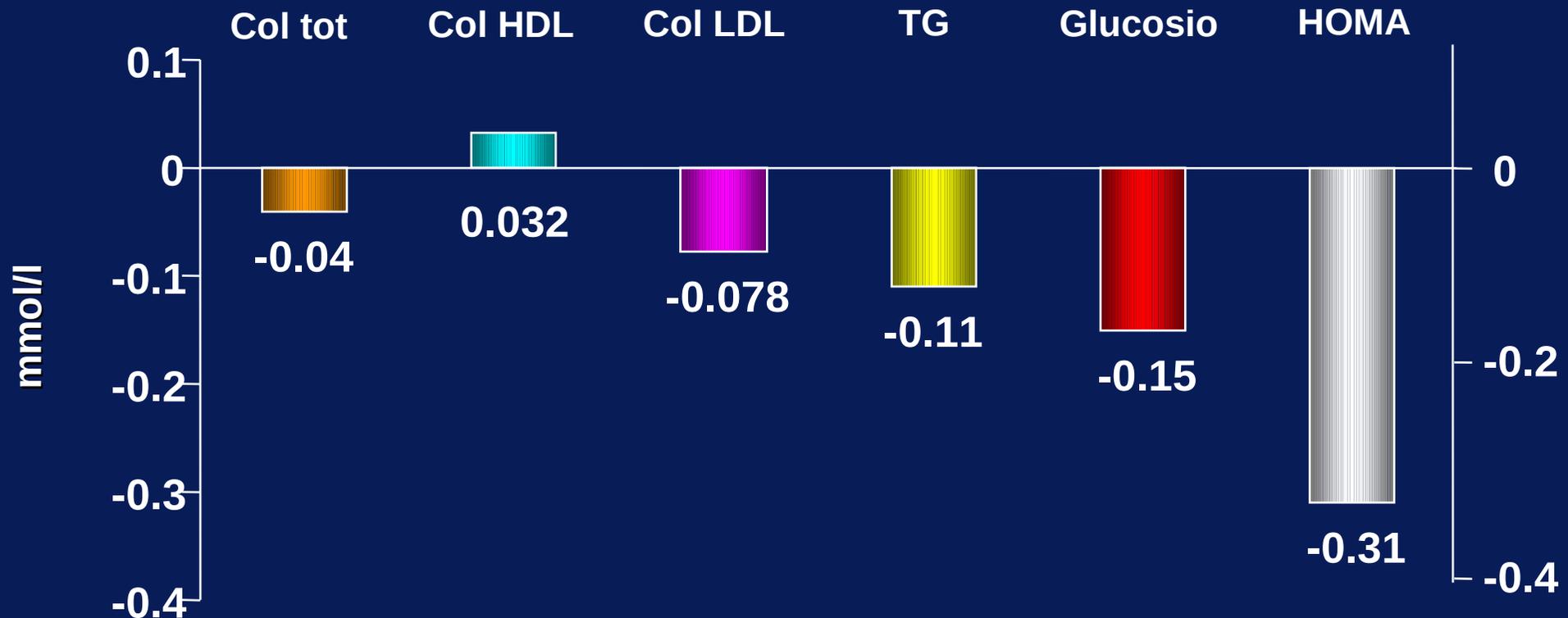


Riduzione mortalità cardiovascolare

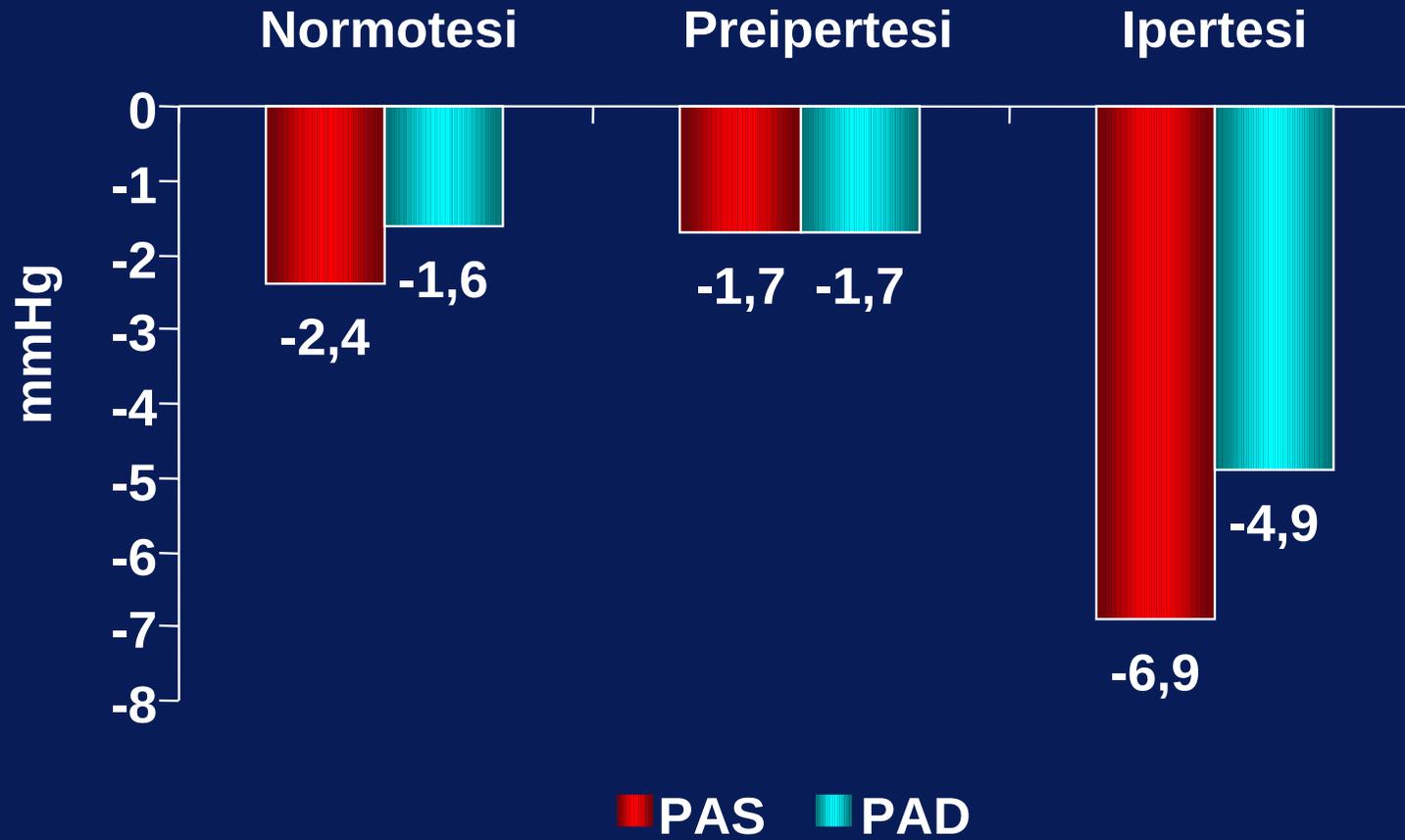
Metanalisi degli studi randomizzati sugli effetti dell'attività fisica aerobica sui parametri metabolici

(Soggetti sedentari sani/ipertesi; esercizio unico intervento; durata ≥ 4 sett.)

72 trial; 3936 soggetti



Metanalisi degli studi randomizzati sugli effetti dell'attività fisica aerobica sui valori pressori



Rischi connessi con l'esercizio fisico nel diabete tipo 2

- Traumi muscolo-scheletrici
- Ipoglicemia (anche tardiva, possibile in caso di terapia con insulina o farmaci che stimolano la secrezione insulinica)
- Evento cardiovascolare acuto
 - cardiopatia ischemica (silente!)
 - neuropatia autonoma
- Aggravamento complicanze croniche severe (retinopatia, piede diabetico)

IDF 2009

Criteri Diagnostici della Sindrome Metabolica (revisione criteri ATP-III 2001)

Tre o più alterazioni fra le seguenti:

- Glicemia a digiuno ≥ 100 mg/dl
- Trigliceridi ≥ 150 mg/dl
- HDL <40 mg/dl M, <50 mg/dl F
- Ipertensione arteriosa ($\geq 130/85$ mmHg)
- Obesità addominale (circonf.vita ≥ 94 cm M, ≥ 80 cm F)

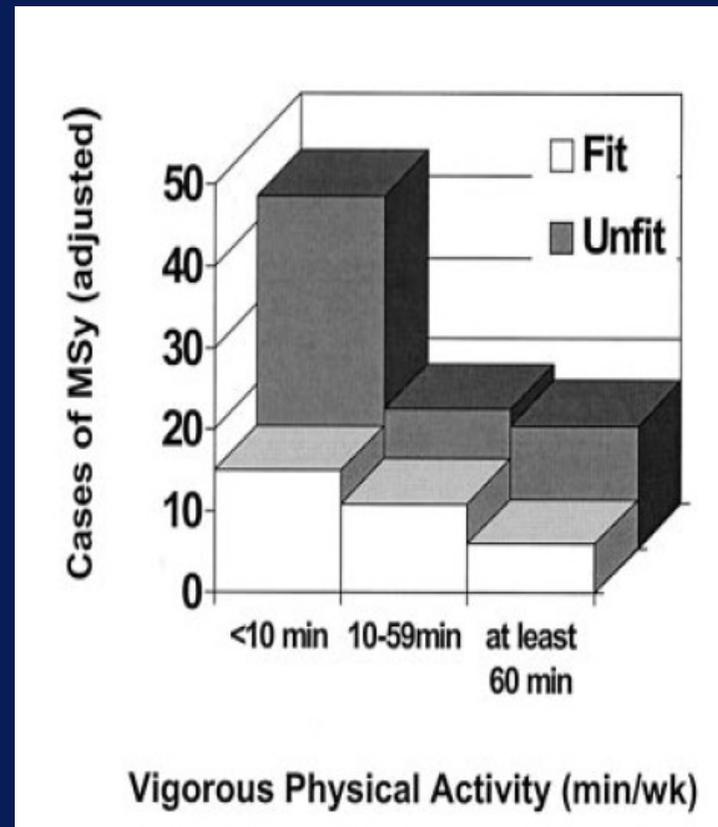
Rischio di comparsa di anomalie metaboliche associato alla ridotta fitness cardiorespiratoria* nel CARDIA Study (n=4487; età 18-30 anni; follow-up 15 anni)

- 3 categorie in base a durata test massimale al treadmill: 1° vs 2°-3° vs 4°-5° quintile -

Anomalie metaboliche	bassa vs alta (HR e 95% CI)	moderata vs alta (HR e 95% CI)
Ipertensione	2.17 (1.69-2.78)	1.34 (1.07-1.67)
Diabete	1.75 (1.01-3.04)	1.25 (0.75-2.09)
Sindrome metabolica (ATP III)	1.87 (1.42-2.48)	1.64 (1.29-2.09)
Ipercolesterolemia	1.02 (0.76-1.36)	1.01 (0.81-1.27)

- Corretto per età, razza, sesso, scolarità, BMI, circonferenza vita, fumo, storia familiare di IMA precoce.

Rischio di sindrome metabolica in rapporto alla fitness cardiorespiratoria (50° centile superiore vs inferiore) e alla quantità di attività fisica intensa (≥ 7.5 MET)



Ridotto rischio di sviluppare sindrome metabolica nei soggetti con maggiore forza muscolare - Aerobics Center Longitudinal Study (1980-2003) -

	Muscular Strength				P Value for Trend
	Q1 (Low)	Q2	Q3	Q4 (High)	
Participants (<i>N</i>)	808	809	808	808	
Man-years of follow-up	5129	5289	5602	5685	
Cases (<i>N</i>)	144	130	120	86	
Age-adjusted rate per 1000 man-years	28.1	24.6	21.3	15.2	<0.0001
HR (95% CI), Model 1*	1.00	0.88 (0.69–1.12)	0.77 (0.60–0.98)	0.54 (0.42–0.71)	<0.0001
HR (95% CI), Model 2†	1.00	0.93 (0.73–1.17)	0.89 (0.70–1.13)	0.66 (0.50–0.86)	0.004
HR (95% CI), Model 3‡	1.00	0.95 (0.75–1.21)	0.93 (0.73–1.18)	0.76 (0.57–0.99)	0.06

HR, hazard ratio; CI, confidence interval.

* Adjusted for age and examination date.

† Additionally adjusted for smoking, alcohol intake, number of metabolic syndrome risk factors at baseline, and family history of diabetes, hypertension, and premature coronary disease.

‡ Additionally adjusted for maximal treadmill time.

Follow-up medio 7 anni.

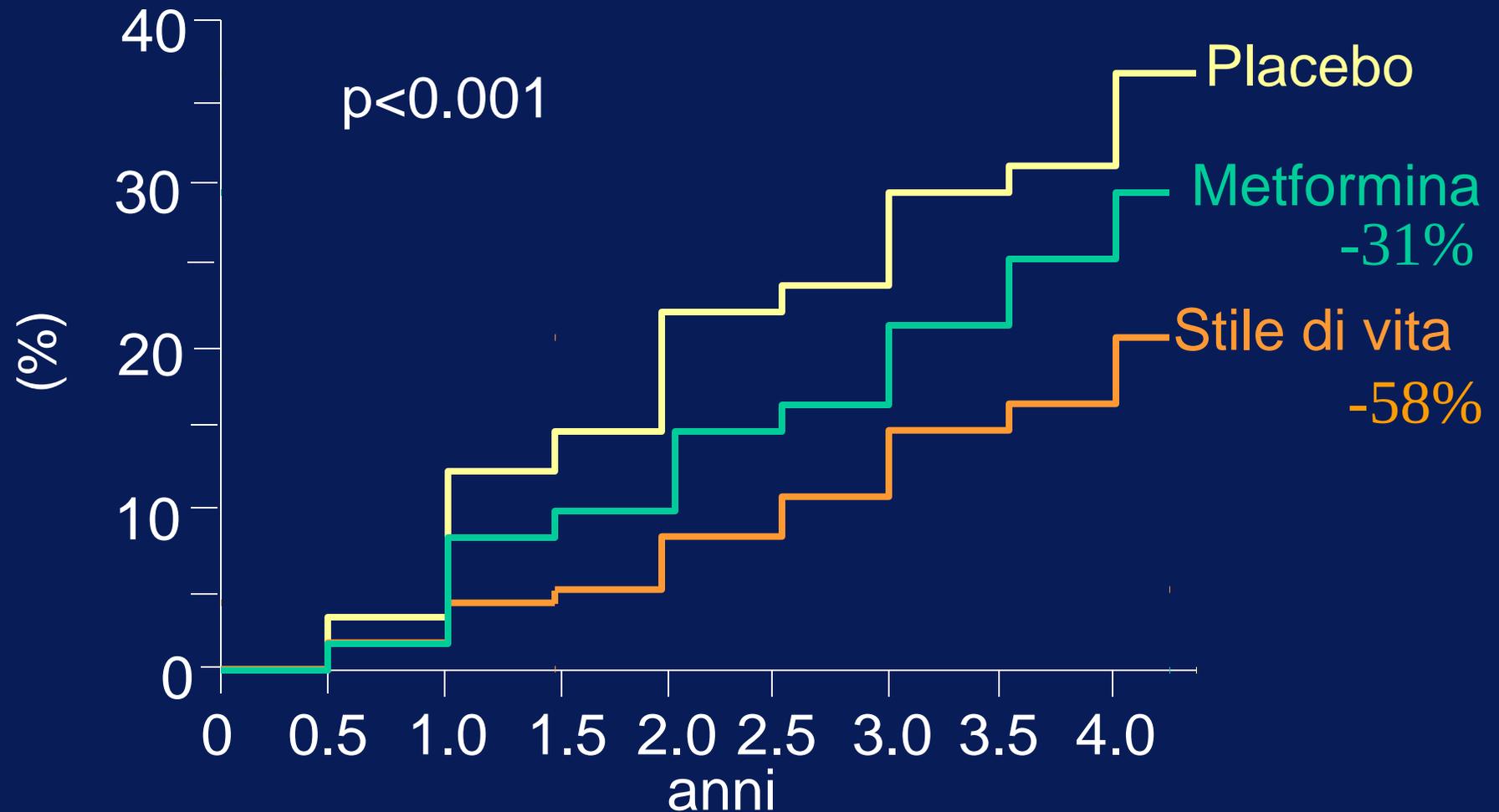
Al basale età media 43 anni, BMI medio 25 kg/m²

Diabetes Prevention Program

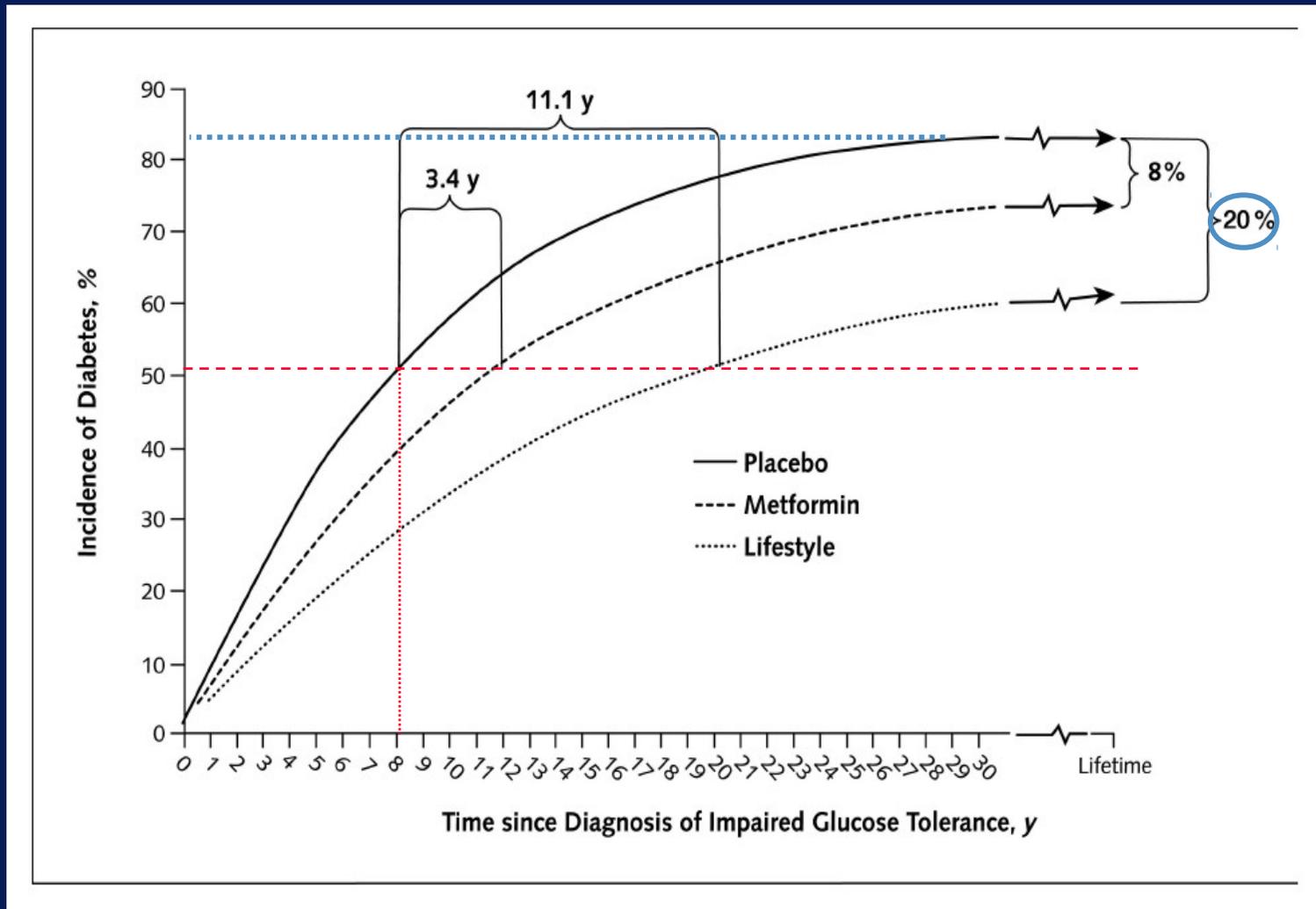
- schema di randomizzazione -



Effetto della modifica dello stile di vita o della terapia con metformina sulla comparsa di diabete tipo 2 in 3234 soggetti con IGT

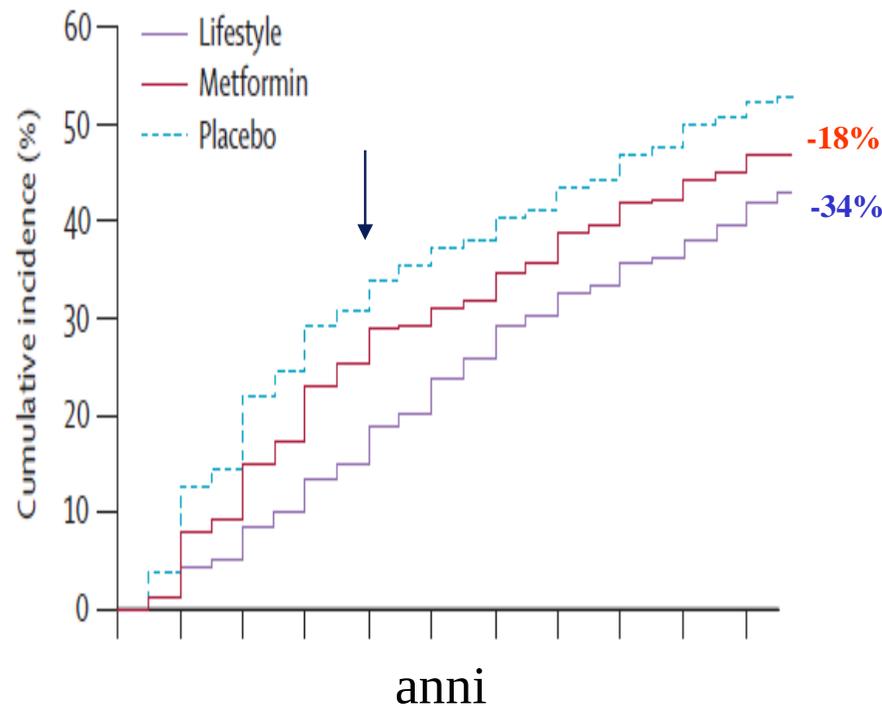


Incidenza cumulativa a lungo termine di diabete in relazione alla terapia in pazienti IGT Estrapolazione dai dati del Diabetes Prevention Program



10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study

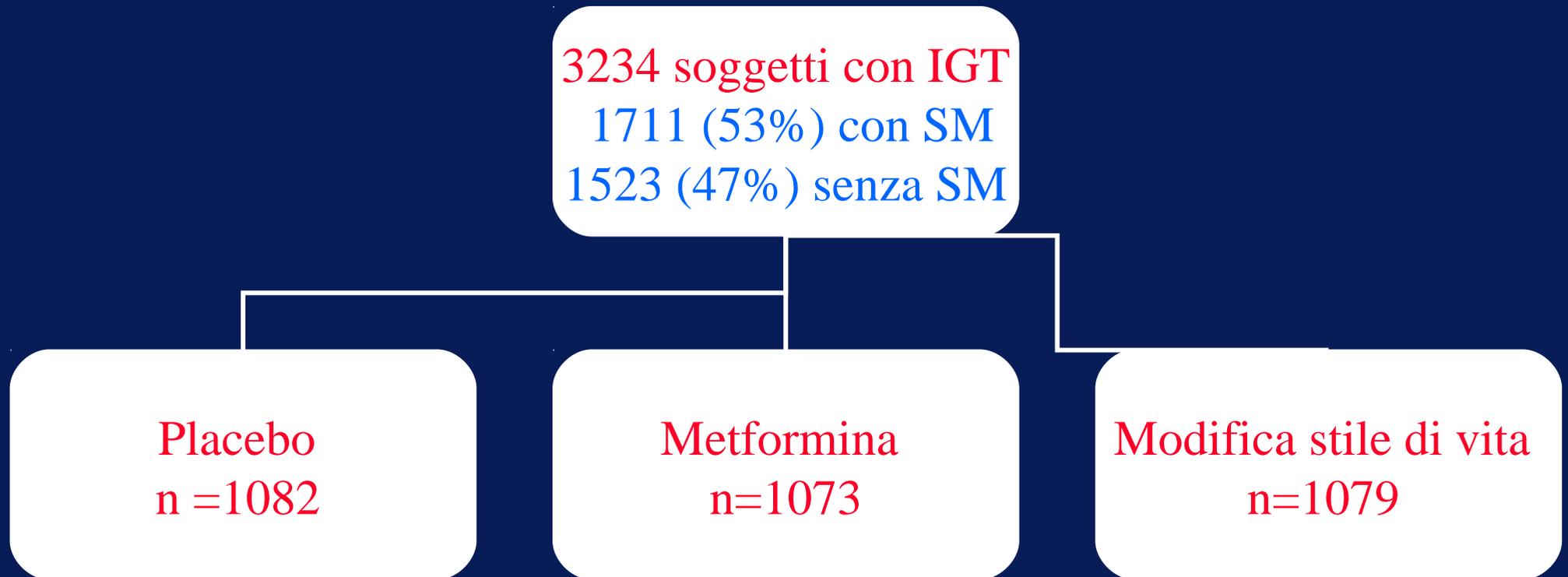
Lancet, November 2009



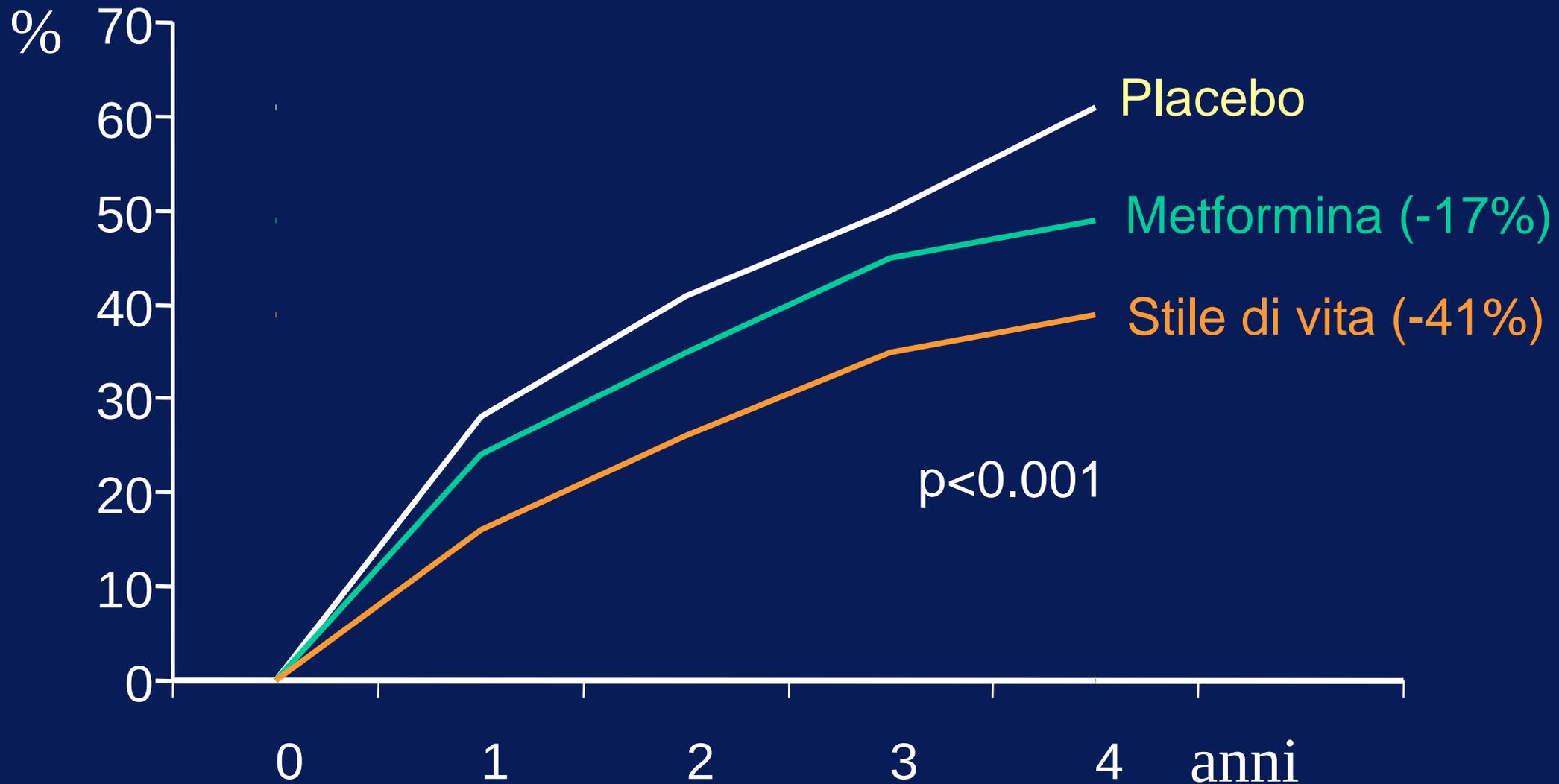
**Frequenza cumulativa
di diabete a 10 anni nel
Diabetes Prevention
Program**

Diabetes Prevention Program

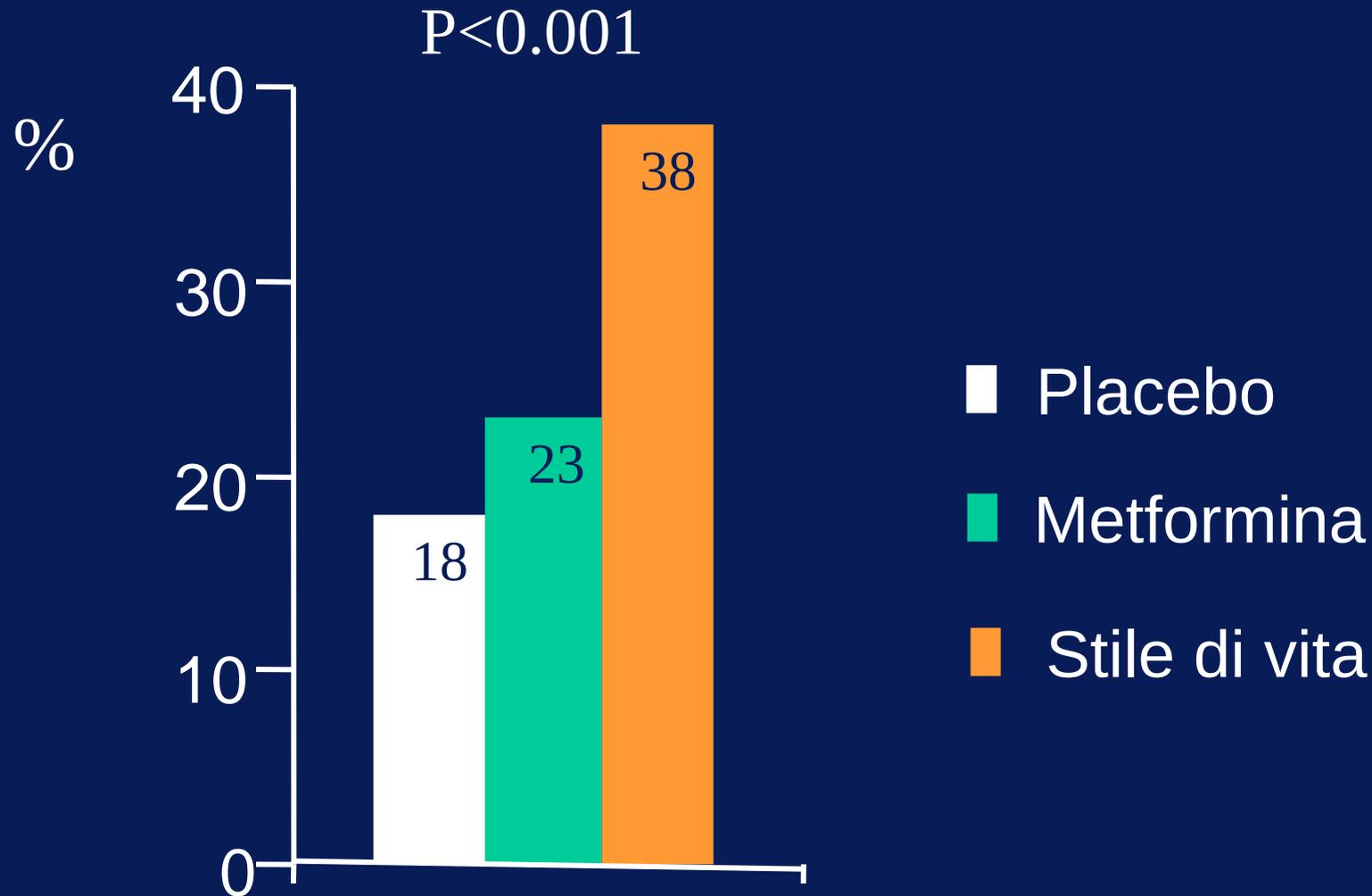
- schema di randomizzazione -



Incidenza cumulativa di sindrome metabolica nei partecipanti al Diabetes Prevention Program



Percentuale di regressione della sindrome metabolica nei partecipanti al Diabetes Prevention Program



Finnish Diabetes Prevention Study

- schema di randomizzazione -

Soggetti con IGT
n=522

Controllo
n=257

Informazioni iniziali verbali
e scritte su stile di vita e salute

Stile di vita
n=265

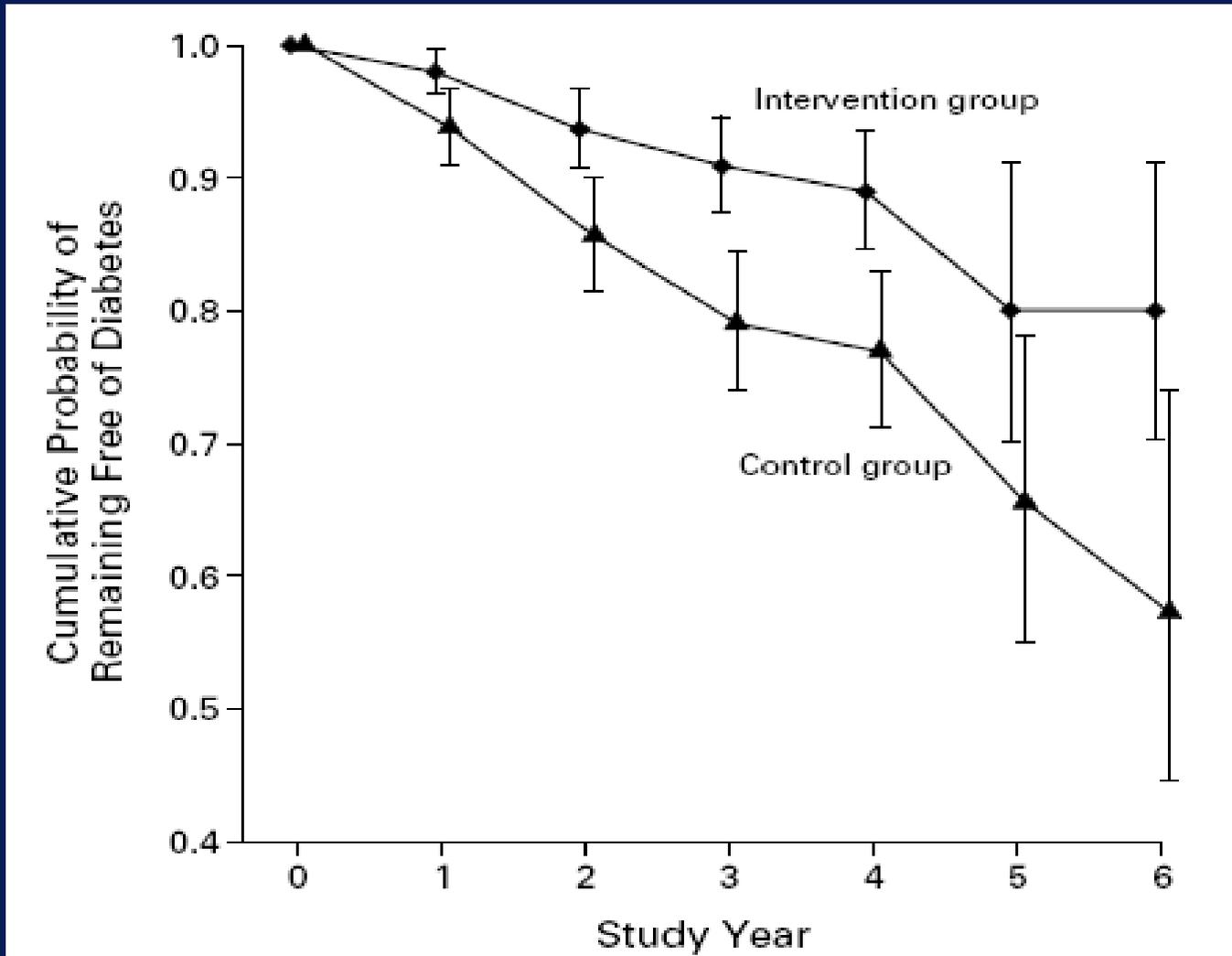
Counseling intensivo per ridurre il peso
di almeno il 5% con dieta ipolipidica
e attività fisica moderata ≥ 30 min/die

conclusione trial dopo 1-6 anni
(mediana 4)

Modalità di intervento sullo stile di vita adottate nel Finnish Diabetes Prevention Study

- **Obiettivi:**
 - riduzione peso $\geq 5\%$
 - introito lipidi $< 30\%$ delle calorie totali (saturi $< 10\%$)
 - fibre > 15 g/1000 Cal
 - attività fisica moderata ≥ 30 min/die
- **Strumenti utilizzati:**
 - counseling intensivo individuale
 - 7 incontri con dietista 1° anno; ogni 3 mesi in seguito (media 20)
 - incentivazione attività fisica
 - disponibilità gratuita supervisione per training di resistenza muscolare

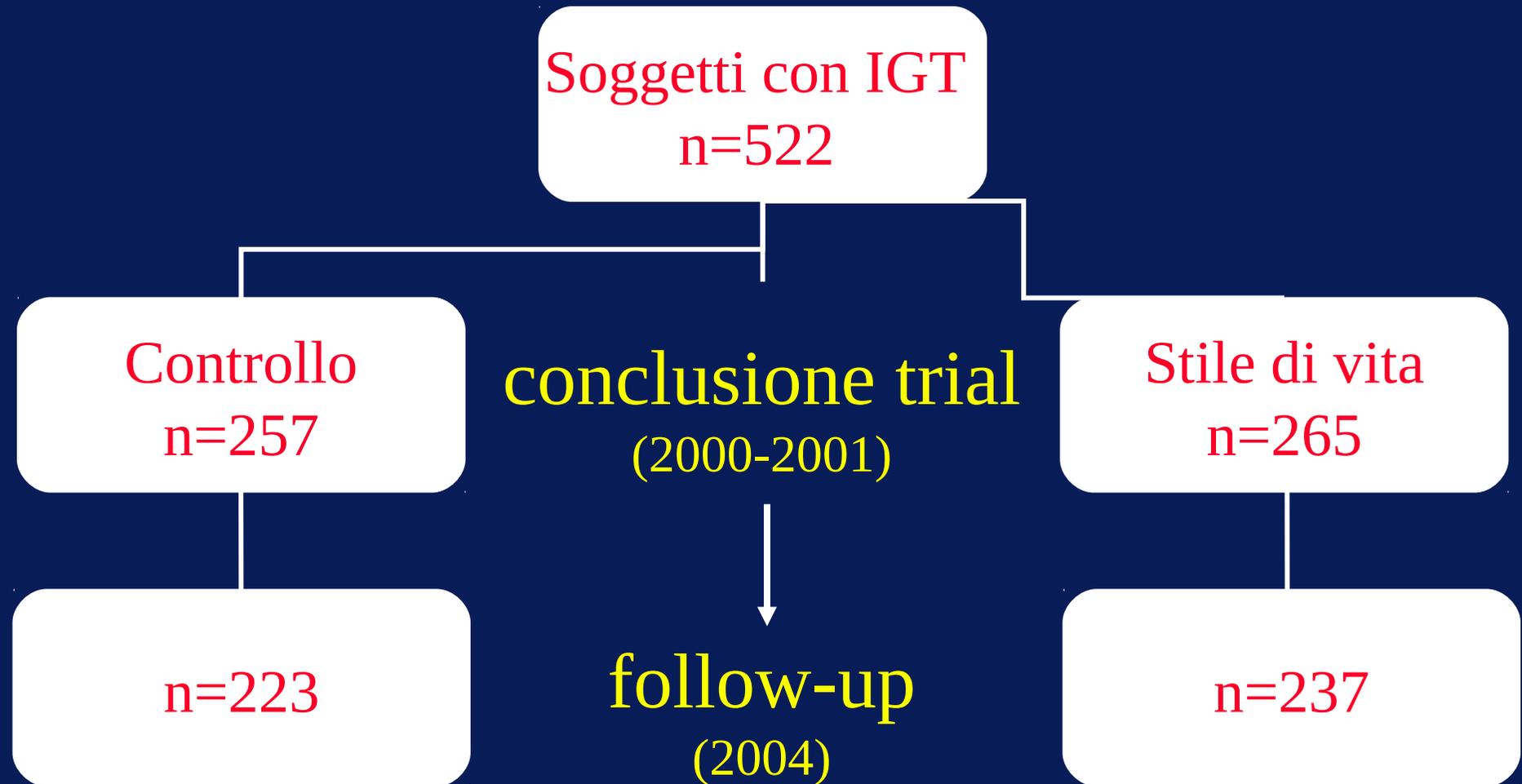
Effetto della modifica dello stile di vita sulla comparsa di diabete tipo 2 nei soggetti con IGT del Finnish Diabetes Prevention Study



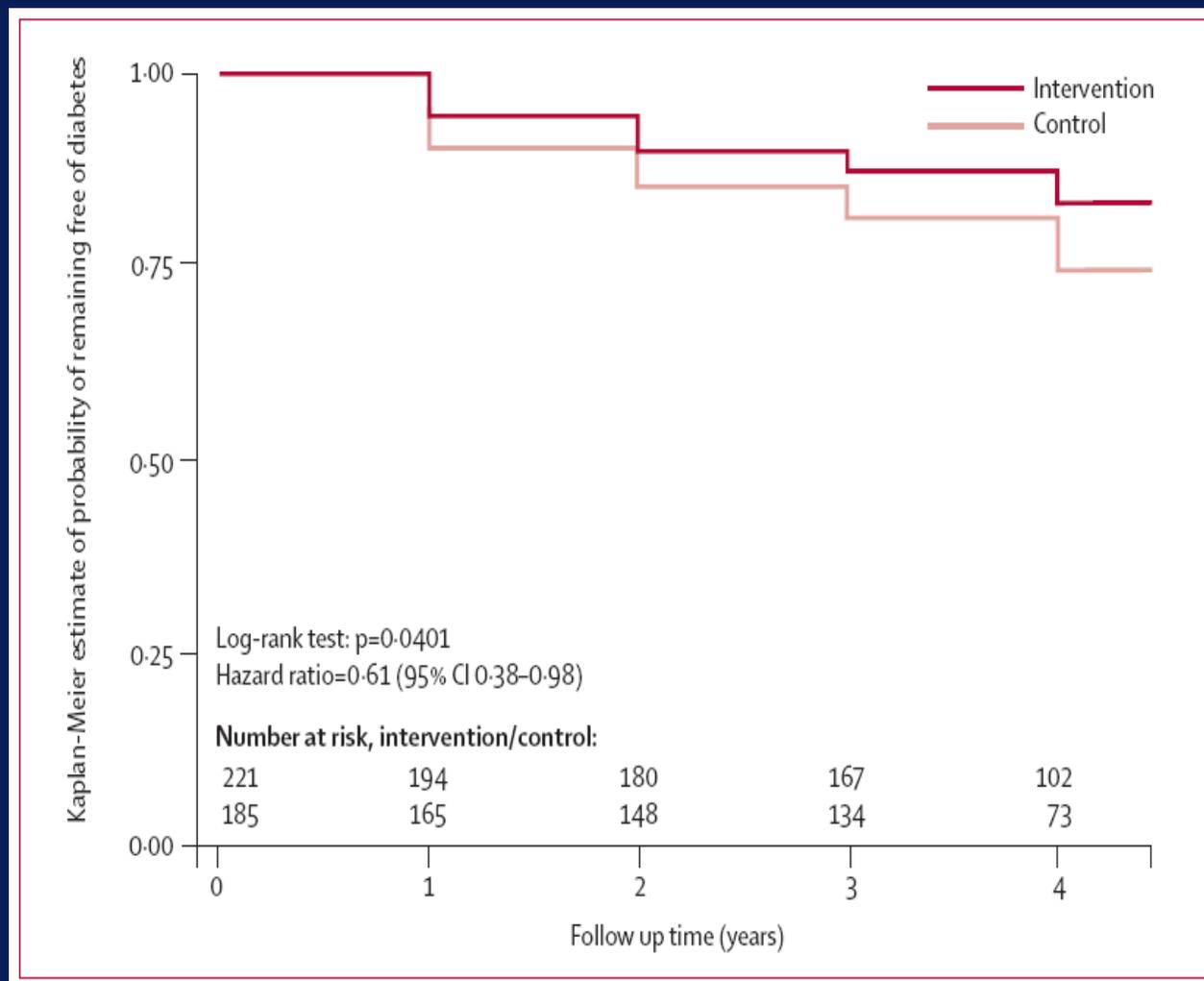
-58%
-p<0.001

Finnish Diabetes Prevention Study

- schema di randomizzazione (1993-1998) -



Rischio di diabete nei soggetti con IGT del Finnish Diabetes Prevention Study riesaminati nel follow-up a lungo termine dopo la conclusione del trial



Caratteristiche dei soggetti del Finnish Diabetes Prevention Study, durante il trial e nel follow-up a distanza

	Intervention		Control		p*	p†
	n	Mean	n	Mean		
Bodyweight (kg)						
Baseline	190	84.9	165	84.0	0.5174	
Last intervention visit	190	81.8	165	83.3	<0.0001	
First post-intervention follow-up visit	190	83.1	165	84.0	0.0032	0.1482
Proportion of physically active (%)‡						
Baseline	184	70	164	70	0.9102	
Last intervention visit	187	88	164	76	0.0035	
First post-intervention follow-up visit	187	86	164	71	0.0005	0.0273
Energy proportion of fat (%)						
Baseline	187	36	159	37	0.1879	
Year 3‡	187	31	159	34	0.0002	
First post-intervention follow-up visit	187	31	159	33	0.0174	0.1189

*p for test of equality between the groups, adjusting for the baseline level. †p for test of equal change between the groups from the last intervention period visit to the first post-intervention follow-up visit, adjusting for the level at the last intervention visit. ‡Individuals who reported walking, cycling, or other moderate intensity activity for at least 4 h a week were categorised as physically active.

Table 2: Bodyweight, physical activity, and dietary intakes of participants of the post-intervention follow-up period who were without diabetes at the end of the intervention

TABLE 3. EFFECTS OF THE AMOUNT AND INTENSITY OF EXERCISE ON LIPIDS, LIPOPROTEINS, AND LIPOPROTEIN SUBFRACTIONS.*

VARIABLE	EFFECT OF AMOUNT OF EXERCISE	EFFECT OF INTENSITY OF EXERCISE	
		rankings	
LDL	Concentration of small LDL particles	High amount, low amount, control	High intensity, moderate intensity, control
	Concentration of LDL particles	High amount, low amount, control	High intensity, moderate intensity, control
	Size of LDL particles	High amount, low amount, control	High intensity, moderate intensity, control
IDL	IDL concentration	High amount, low amount, control	High intensity, moderate intensity, control
HDL	Concentration of large HDL particles	High amount, low amount, control	High intensity, moderate intensity, control
	Size of HDL particles	High amount, low amount, control	High intensity, moderate intensity, control
	HDL cholesterol concentration	High amount, low amount, control	Moderate intensity, high intensity, control
VLDL	Concentration of large VLDL particles	High amount, low amount, control	Moderate intensity, high intensity, control
	Size of VLDL particles	Low amount, high amount, control	Moderate intensity, high intensity, control
	Total triglyceride concentration	High amount, low amount, control	Moderate intensity, high intensity, control
	VLDL triglyceride concentration	High amount, low amount, control	Moderate intensity, high intensity, control

Ordine di efficacia di diverse quantità e intensità dell'attività fisica sulle lipoproteine circolanti

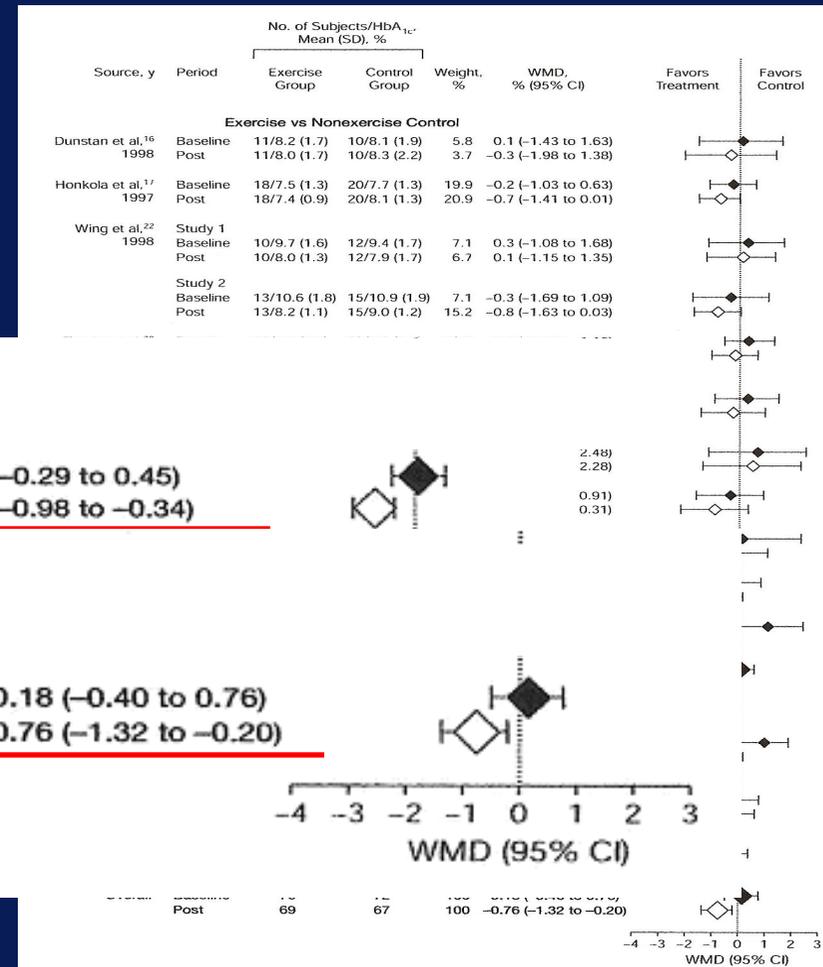
Effetti di diversi volumi di attività fisica (MET h/sett) in diabetici tipo 2

	0	1-10	11-20	21-30	31-40	> 40
Peso Kg	+ 0.8	+ 0.6	+ 0.1	- 2.2	- 3.0	- 3.2
Circonf. vita cm	+ 1.0	+ 1.0	- 0.9	- 3.8	- 5.5	- 7.1
HbA1c %	+ 0.03	- 0.06	- 0.44	- 0.88	- 1.11	- 1.19
PA max mmHg	- 1.8	- 1.5	- 6.4	- 5.5	- 6.6	- 9.2
PA min mmHg	- 4.6	- 2.4	- 2.9	- 4.8	- 5.3	- 7.1
Col. tot mg/dl	- 3.8	- 5.6	- 10.2	- 10.7	- 7.4	- 10.9
Col. LDL mg/dl	- 4.5	- 7.1	- 3.4	- 5.3	- 6.3	- 7.7
Col. HDL mg/dl	+ 0.1	+ 1.1	+ 2.9	+ 5.6	+ 10.4	+ 6.3
TG mg/dl	+ 3.4	+ 2.1	- 48.2	- 55.2	- 57.4	- 68.4
CHD %	+ 0.1	- 0.3	- 2.6	- 3.7	- 4.8	- 4.3

p<0.05-0.01

Di Loreto et al, 2006

METANALISI DEGLI STUDI CONTROLLATI SUGLI EFFETTI DELL'ATTIVITA' FISICA AEROBICA SULLA HbA1c NEL DIABETE TIPO 2



Esercizio

Overall Baseline 154 156 100 0.08 (-0.29 to 0.45)
Post 154 156 100 -0.66 (-0.98 to -0.34)

Esercizio
+ dieta

Overall Baseline 70 72 100 0.18 (-0.40 to 0.76)
Post 69 67 100 -0.76 (-1.32 to -0.20)

Boulè et al, JAMA 2001

Strength Training Increases Insulin-Mediated Glucose Uptake, GLUT4 Content, and Insulin Signaling in Skeletal Muscle in Patients With Type 2 Diabetes

Mads K. Holten,^{1,2} Morten Zacho,² Michael Gaster,³ Carsten Juel,^{2,4} Jørgen F.P. Wojtaszewski,^{2,5} and Flemming Dela^{1,2}
DIABETES, VOL. 33, FEBRUARY 2004

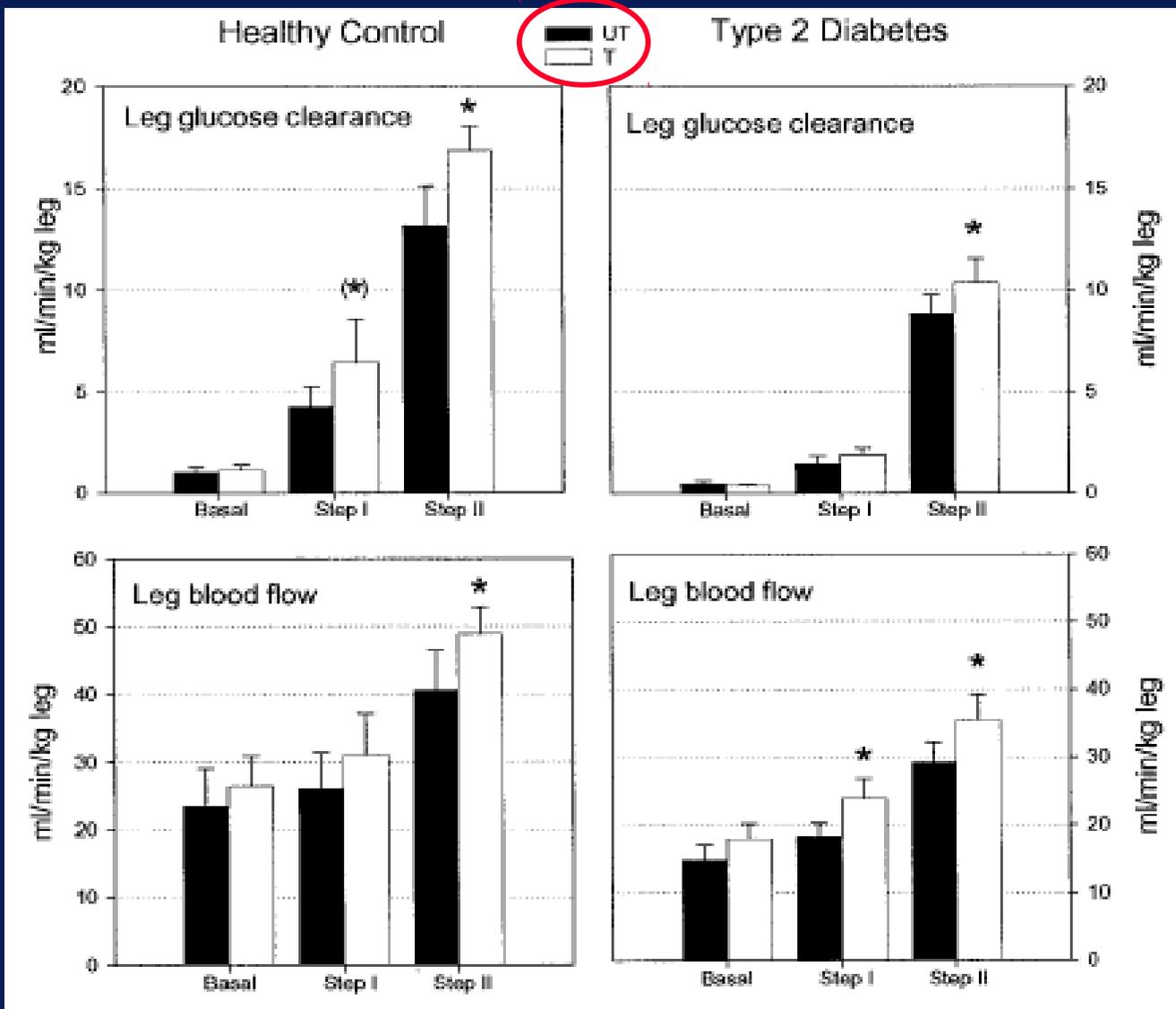
- disegno sperimentale -



Dopo 6 settimane di allenamento moderato supervisionato (30' x 3/settimana):

- clamp euglicemico con cateterismo artero-venoso femorale bilaterale
- biopsia muscolare su entrambi gli arti

Clearance del glucosio e flusso sanguigno alla gamba, basali e durante clamp, nell'arto sottoposto ad allenamento di forza e in quello non allenato in controllati e diabetici tipo 2



Allenamento supervisionato:
30'x3/settimana x 6 settimane

Infusione insulinica nel clamp:
28 and 480 mU/m² min

High-Intensity Resistance Training Improves Glycemic Control in Older Patients With Type 2 Diabetes

Diabetes Care 25:1729-1736, 2002

DAVID W. DUNSTAN, PHD¹
ROBIN M. DALY, PHD²
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MAXIMILIAN DE COURTEN, MD¹
JONATHAN SHAW, MD¹
PAUL ZIMMET, PHD¹

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part of a well-rounded e
for older individuals. How
progressive resistance tra
ment regimen for impro

36 soggetti diabetici tipo 2 (67-70 anni) in sovrappeso e con controllo glicemico non ottimale randomizzati a:

- **gruppo di controllo (dieta + esercizi di stretching)**
- **gruppo di esercizio di resistenza muscolare (dieta + 9 esercizi con durata complessiva 50 min x 3 volte per settimana):**

1-2 sett.: 1 set x 8-10 ripetizioni al 50-60% di 1 RM

3-26 sett.: 3 set x 8-10 ripetizioni al 75-85% di 1 RM

Tab. 6— Variazioni assolute di parametri antropometrici, forza muscolare, pressione sanguigna, spesa energetica rispetto al basale nei gruppi di esercizio (RT) e dieta (WL), con differenza netta di variazioni fra i due gruppi (da ref. 74).

	3-month change from baseline			6-month change from baseline		
	RT	WL	Net difference (95% CI)	RT	WL	Net difference (95% CI)
Anthropometry						
Body mass (kg)	-1.8 ± 2.0*	-2.0 ± 1.5 [†]	0.2 (-1.2 to 1.6)	<u>-2.5 ± 2.9*</u>	<u>-3.1 ± 2.1*</u>	0.6 (-1.3 to 2.6)
Waist circumference (cm)	-3.8 ± 3.5*	-3.1 ± 3.2 [†]	-0.7 (-3.3 to 2.0)	-6.9 ± 5.7*	-6.7 ± 6.1*	-0.2 (-4.8 to 4.2)
Body Composition						
Fat mass (kg)	—	—	—	-2.4 ± 2.8*	-2.1 ± 2.5*	0.3 (-2.4 to 1.8)
LBM (kg)	—	—	—	<u>0.5 ± 1.2</u>	<u>-0.4 ± 1.0</u>	0.9 (0.05–1.8)
Muscle strength						
Upper body (% change)	30.5 ± 18.8*	7.6 ± 15.7	22.9 (7.6–38.2)	<u>43.2 ± 34.2*</u>	<u>1.5 ± 17.7</u>	41.7 (14.4–69.0)
Lower body (% change)	8.0 ± 17.1	2.1 ± 18.4	5.9 (-8.9 to 20.6)	<u>33.0 ± 21.7*</u>	<u>5.0 ± 16.9</u>	28.0 (9.1–46.9)
Resting blood pressure (mmHg)						
Systolic	-4.9 ± 13.9	-3.8 ± 13.6	-1.1 (-11.7 to 9.4)	-6.7 ± 10.0	-2.5 ± 15.8	-4.2 (-14.1 to 5.7)
Diastolic	-3.6 ± 7.4	-0.9 ± 6.8	-2.7 (-8.1 to 2.8)	-4.4 ± 6.9	-0.9 ± 10.1	-3.5 (-10.0 to 3.0)
Energy expenditure (kcal/day)	-38 ± 209	-80 ± 207	42 (-117 to 202)	-97 ± 204	-55 ± 253	-42 (-216 to 131)
Total energy intake (kcal/day)	-275 ± 343	-241 ± 311	-34 (-309 to 241)	-281 ± 418	-391 ± 251*	110 (-193 to 413)

Tab 5— Variazioni assolute dei parametri metabolici dopo intervento con allenamento di resistenza muscolare (RT) o dieta (WL), e differenza di risultati fra i due gruppi (da ref. 74).

	3-month change from baseline			6-month change from baseline		
	RT	WL	Net difference (95% CI)	RT	WL	Net difference (95% CI)
Fasting plasma glucose (mmol/l)	-0.5 ± 2.3	0.09 ± 2.5	-0.6 (-2.4 to 1.3)	-1.4 ± 2.7	-0.6 ± 2.4	-0.8 (-2.8 to 1.2)
Fasting serum insulin (pmol/l)	7.1 ± 43.3	16.4 ± 60.3	-9.3 (-48.8 to 30.2)	10.5 ± 46.3	-4.7 ± 27.2	15.2 (-14.7 to 45.1)
Insulin sensitivity (HOMA) (%)	-1.3 ± 4.6	-0.3 ± 6.1	-1.0 (-5.2 to 3.1)	0.03 ± 5.2	0.8 ± 6.5	-0.8 (-5.2 to 3.7)
HbA _{1c} (%)	<u>-0.6 ± 0.7*</u>	<u>-0.07 ± 0.8</u>	-0.5 (-1.1 to -0.01) [°]	<u>-1.2 ± 1.0*</u>	<u>-0.4 ± 0.8</u>	-0.8 (-1.5 to -0.1) [°]
Total cholesterol	-0.03 ± 0.6	-0.2 ± 0.9	0.2 (-0.4 to 0.7)	-0.09 ± 0.8	-0.5 ± 0.8	0.4 (-0.3 to 1.1)
HDL cholesterol	0.02 ± 0.1	0.07 ± 0.2	-0.05 (-0.1 to 0.05)	0.06 ± 0.1	0.07 ± 0.2	-0.01 (-0.1 to 0.1)
LDL cholesterol	0.03 ± 0.4	-0.2 ± 0.9	0.2 (-0.3 to 0.7)	-0.06 ± 0.7	-0.5 ± 0.9	0.4 (-0.2 to 1.0)
Triglycerides	-0.2 ± 0.7	-0.05 ± 0.9	-0.2 (-0.8 to 0.4)	-0.2 ± 0.7	-0.08 ± 0.6	-0.1 (-0.7 to 0.4)

Data are means ± SD or means (95% CI). * $P < 0.01$, [°] $P < 0.05$ within-group difference from baseline

FATTORI CHE AUMENTANO LA CAPTAZIONE MUSCOLARE DI GLUCOSIO DOPO ALLENAMENTO DI FORZA

- Aumento della **massa muscolare**
- Aumento del **letto vascolare** nel settore allenato
- **Modificazioni funzionali** nel muscolo allenato
 - aumento recettori insulinici
 - aumento trasportatori del glucosio
 - aumento espressione e attività glicogeno-sintasi

Consumo energetico legato all'attività fisica espresso in MET

Attività	METs
Atleta durante una top performance	20
Corsa amatoriale	9.5
Nuotare	7.0
Giardinaggio generale	4.0
Camminare (di buon passo)	4.0
Bicicletta per piacere	4.0
Danza veloce	4.5
Danza lenta	3.0
Mestieri pesanti	3-6
Mestieri leggeri	2.5
Lavoro d'ufficio	1.8
Guida in auto	1.5

Effects of Aerobic Training, Resistance Training, or Both on Glycemic Control in Type 2 Diabetes

A Randomized Trial

Ronald J. Sigal, MD, MPH; Glen P. Kenny, PhD; Normand G. Boulé, PhD; George A. Wells, PhD; Denis Prud'homme, MD, MSc; Michelle Fortier, PhD; Robert D. Reid, PhD, MBA; Heather Tulloch, MSc; Douglas Coyle, PhD; Penny Phillips, MA; Alison Jennings, MA; and James Jaffey, MSc

N=251 T2DM (multicentrico)

Durata intervento: 22 settimane (3 sedute/settimana)

Dieta stabile

Randomizzazione a 4 gruppi:

- a) a. **aerobica** (treadmill, cicloergometro): 45' al 75% HRmax
- b) a. di **resistenza** (macchine): 3 serie di 7 esercizi a 7-9 RM
- c) a. **combinata**: a+b
- d) gruppo di **controllo** sedentario

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Variable	Mean Value (SD)			Difference in Change from Baseline to 6 Months (95% CI)	P Value
	Baseline	3 mo	6 mo		
Body weight, kg					
Combined exercise group	101.9 (30.4)	100.2 (30.4)	99.3 (30.4)	–	–
Aerobic training group	103.5 (31.0)	101.8 (30.2)	100.9 (30.2)	–	–
Resistance training group	99.1 (30.4)	98.1 (30.4)	98.0 (30.4)	–	–
Control group	101.3 (28.6)	100.5 (27.8)	101.0 (27.8)	–	–
Intergroup comparisons					
Aerobic training vs. control	–	–	–	–2.2 (–3.9 to –0.6)	0.008
Resistance training vs. control	–	–	–	–0.7 (–2.4 to 0.9)	0.36
Combined exercise vs. aerobic training	–	–	–	0.0 (–1.6 to 1.7)	0.98
Combined exercise vs. resistance training	–	–	–	–1.5 (–3.1 to 0.1)	0.075

Effects of Aerobic Training, Resistance Training, or Both on Glycemic Control in Type 2 Diabetes

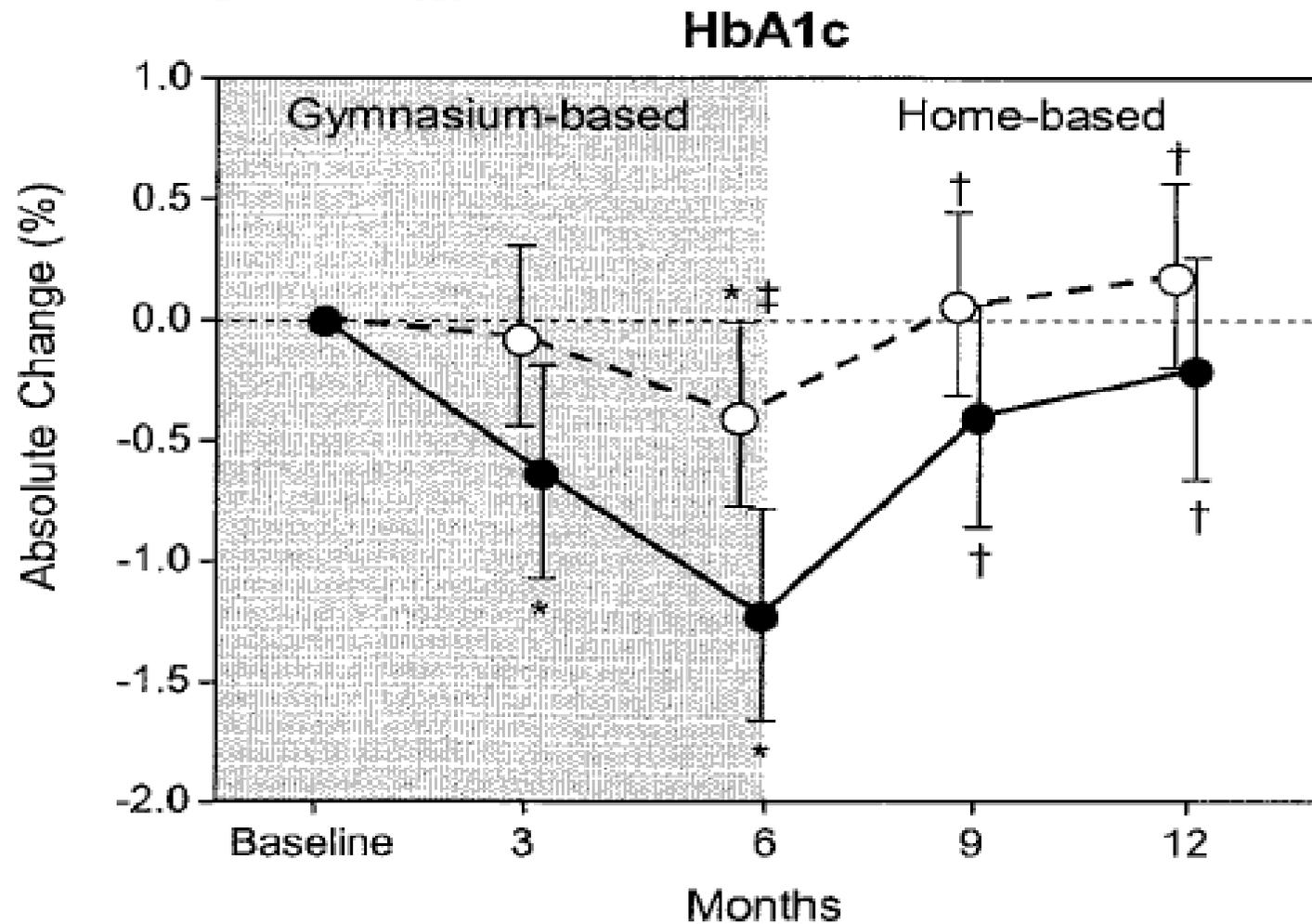
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Variable	Mean (SD) Value			Difference in Change from Baseline to 6 Months (95% CI)	P Value
	Baseline	3 mo	6 mo		
Hemoglobin A_{1c} [patients], % [n]†					
Combined exercise group	7.46 (1.48) [64]	6.99 (1.56) [60]	6.56 (1.55) [58]	–	–
Aerobic training group	7.41 (1.50) [60]	7.00 (1.59) [58]	6.98 (1.50) [49]	–	–
Resistance training group	7.48 (1.47) [64]	7.35 (1.57) [62]	7.18 (1.52) [56]	–	–
Control group	7.44 (1.38) [63]	7.33 (1.49) [62]	7.51 (1.47) [59]	–	–
Intergroup comparisons					
Aerobic training vs. control	–	–	–	–0.51 (–0.87 to –0.14)	0.007
Resistance training vs. control	–	–	–	–0.38 (–0.72 to –0.22)	0.038
Combined exercise vs. aerobic training	–	–	–	–0.46 (–0.83 to –0.09)	0.014
Combined exercise vs. resistance training	–	–	–	–0.59 (–0.95 to –0.23)	0.001

Home-Based Resistance Training Is Not Sufficient to Maintain Improved Glycemic Control Following Supervised Training in Older Individuals With Type 2 Diabetes

Absolute change in HbA_{1c} from baseline in RT&WL (●) and WL (○) groups



- High intensity resistance training + weight loss vs weight loss alone
- 6 months of supervised training + 6 months of home-based training

Dunstan et al,
Diabetes Care 2005

Exercise and Type 2 Diabetes

The American College of Sports Medicine and the American Diabetes Association: joint position statement [Colberg et al, Diabetes Care, December 2010](#)

AEROBIC EXERCISE

Frequency. Aerobic exercise should be performed at least 3 days/week with no more than 2 consecutive days between bouts of activity because of the transient nature of exercise-induced improvements in insulin action (26,141). Most clinical trials evaluating exercise interventions in type 2 diabetes have used a frequency of three times per week (24,238,246,255), but current guidelines for adults generally recommend five sessions of moderate activity (105,202,217).

Intensity. Aerobic exercise should be at least at moderate intensity, corresponding approximately to 40–60% of $\dot{V}O_{2max}$ (maximal aerobic capacity). For most people with type 2 diabetes, brisk walking is a moderate-intensity exercise. Additional benefits may be gained from vigorous exercise (>60% of $\dot{V}O_{2max}$). A meta-analysis (25) showed that exercise intensity predicts improvements in overall BG control to a greater extent than exercise volume, suggesting that those already exercising at a moderate intensity should consider undertaking some vigorous PA to obtain additional BG (and likely CV) benefits.

Duration. Individuals with type 2 diabetes should engage in a minimum of 150 min/week of exercise undertaken at moderate intensity or greater. Aerobic activity should be performed in bouts of at least 10 min and be spread throughout the week. Around 150 min/week of moderate-intensity exercise is associated with reduced morbidity and mortality in observational studies in all populations (217). The average weekly duration in meta-analyses of exercise interventions in type 2 diabetes (24,246,255), including higher-intensity aerobic exercise (196), has been in a similar range. Recent joint ACSM/American Heart Association guidelines (105,202) recommended 150 min of moderate activity (30 min, 5 days/week) or 60 min of vigorous PA (20 min on 3 days) for all adults, whereas recent U.S. federal guidelines (217) recommended 150 min of moderate or 75 min of vigorous activity, or an equivalent combination, spread throughout each week.

The U.S. federal guidelines (217) suggest that an exercise volume of 500–1,000 MET · min/week (MET equivalent of PA × number of minutes) is optimal and can be achieved, for example, with 150 min/week of walking at 6.4 km/h (4 mph; intensity of 5 METs) or 75 min of jogging at 9.6 km/h (6 mph; 10 METs). Unfortunately, most people with type 2 diabetes do not have sufficient aerobic capacity to jog at 9.6 km/h for that weekly duration, and they may have orthopedic or other limitations. In a meta-analysis, the mean maximal aerobic capacity in diabetic individuals was only 22.4 ml/kg/min, or 6.4 METs (25), making 4.8 METs (75% of maximal) the highest sustainable intensity. Therefore, most diabetic individuals will require at least 150 min of moderate to vigorous aerobic exercise per week to achieve optimal CVD risk reduction. Some CV and BG benefits may be gained from lower exercise volumes (a minimum dose has not been established),

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RESISTANCE EXERCISE

Frequency. Resistance exercise should be undertaken at least twice weekly on nonconsecutive days (1,105,202,217,239,240), but more ideally three times a week (65,246), as part of a PA program for individuals with type 2 diabetes, along with regular aerobic activities.

Intensity. Training should be moderate (50% of 1-repetition maximum [1-RM]) or vigorous (75–80% of 1-RM) for optimal gains in strength and insulin action (1,97,239,240,263). Home-based resistance training following supervised, gym-based training may be less effective for maintaining BG control but adequate for maintaining muscle mass and strength (66).

Duration. Each training session should minimally include 5–10 exercises involving the major muscle groups (in the upper body, lower body, and core) and involve completion of 10–15 repetitions to near fatigue per set early in training (1,97,239,240,263), progressing over time to heavier weights (or resistance) that can be lifted only 8–10 times. A minimum of one set of repetitions to near fatigue, but as many as three to four sets, is recommended for optimal strength gains.

Mode. Resistance machines and free weights (e.g., dumbbells and barbells) can result in fairly equivalent gains in strength and mass of targeted muscles (66). Heavier weights or resistance may be needed for optimization of insulin action and BG control (276).

Rate of progression. To avoid injury, progression of intensity, frequency, and duration of training sessions should occur slowly. In most progressive training, increases in weight or resistance are undertaken first and only once when the target number of repetitions per set can consistently be exceeded, followed by a greater number of sets and lastly by increased training frequency. Progression for 6 months to thrice-weekly sessions of three sets of 8–10 repetitions done at 75 to 80% of 1-RM on 8–10 exercises may be an optimal goal (65).



Raccomandazioni AMD/SID relative all'attività fisica aerobica

Livello della prova I, forza della raccomandazione A

Allo scopo di

- migliorare il controllo glicemico
- favorire il mantenimento di un peso ottimale
- ridurre il rischio cv
- Almeno 150 min/settimana di attività aerobica moderata (50-70% HR max) o 90 min di attività vigorosa
- distribuita su almeno 3 giorni/settimana
- con intervalli senza attività non superiori a 2 giorni



Raccomandazioni AMD/SID relative all'attività fisica di forza

Livello della prova I, forza della raccomandazione A

- L'esercizio fisico contro resistenza si è dimostrato efficace nel migliorare il controllo glicemico
- I pazienti devono essere incoraggiati a eseguire esercizio contro resistenza a carico di tutti i maggiori gruppi muscolari, per almeno 3 giorni/settimana, secondo un programma definito con il diabetologo

- In soggetti non allenati, gravemente obesi e con sarcopenia relativa, l'introduzione graduale di un programma di esercizi contro resistenza, quali piccoli pesi, può consentire l'avvio di attività aerobiche, favorendo potenziamento muscolare, aumento della capacità aerobica e calo ponderale.
(Livello della prova VI, Forza della raccomandazione B)



Prima di avviare un paziente diabetico a programmi di esercizio fisico va prescritto un test da sforzo?

- L'utilizzo del test da sforzo in soggetti diabetici asintomatici a basso rischio di coronaropatia, intenzionati a intraprendere un programma di attività fisica (moderata), non è raccomandato (rischio di evento cardiaco a 10 anni $< 10\%$).
- (Livello della prova VI, Forza della raccomandazione D)

Patologie metaboliche ed esercizio

- L'esercizio ha effetti benefici sui meccanismi patogenetici alla base della sindrome metabolica e migliora i fattori di rischio cardiovascolare che la caratterizzano: è uno strumento di prevenzione e di cura.
- Le modalità ottimali con cui l'attività fisica dovrebbe essere effettuata per raggiungere questo obiettivo, in termini di tipologia di esercizio, durata, intensità e frequenza, restano da definire.