

KATHOLIEKE UNIVERSITEIT
LEUVEN

Metabool Syndroom & Lichamelijke Activiteit

Prof.dr. Luc Vanhees
Leiden, 26/9/2007

Metabool Syndroom

(Lakka et al, Appl Physiol Nutr Metab, 2007)

MS & Lichamelijke Activiteit

- Preventie:
 - Relatie tussen fysieke (in)activiteit en metabool syndroom
- Behandeling
 - Effecten
 - Soort training?
 - Conclusie
- Aanbevelingen

MS & Preventie: Sedentaire Leefstijl

Television Watching and Other Sedentary Behaviors in Relation to Risk of Obesity and Type 2 Diabetes Mellitus in Women

Hu, FB, Li TY, Colditz, GA, Willett WC, Manson JE, JAMA, 289:1785-1791, 2003

MS & Preventie: Sedentaire Leefstijl Nurses' Health Study

Analyse Obesiteit (BMI >30) : n=50277 → na 6 jr FU: 3757 subjects obese

	No. of Hours					P for Trend
	0-1	2-5	6-20	21-40	>40	
Sitting while watching television	226	872	2043	530	86	
Person-years	21 242	70 616	148 425	26 659	5198	
Age-adjusted RR (95% CI)	1.00	1.23 (1.06-1.42)	1.42 (1.24-1.63)	1.69 (1.43-1.96)	2.00 (1.66-2.57)	<.001
Multivariate RR (95% CI)*	1.00	1.24 (1.07-1.42)	1.44 (1.25-1.66)	1.67 (1.43-1.95)	1.97 (1.53-2.59)	<.001
Multivariate RR (95% CI)†	1.00	1.22 (1.06-1.42)	1.42 (1.24-1.63)	1.65 (1.41-1.93)	1.94 (1.51-2.49)	<.001

Analyse Diabetes type 2: n=68497 → na 6 jr FU: 1515 subject Diabetes 2

	No. of Hours					P for Trend
	0-1	2-5	6-30	21-40	>40	
Sitting while watching television	81	315	810	258	51	
Person-years	27 966	87 533	208 128	54 810	5003	
Age-adjusted RR (95% CI)	1.00	1.10 (0.86-1.43)	1.30 (1.04-1.64)	1.53 (1.19-1.96)	1.98 (1.30-2.81)	<.001
Multivariate RR (95% CI)*	1.00	1.10 (0.86-1.41)	1.33 (1.06-1.68)	1.49 (1.16-1.92)	1.77 (1.24-2.52)	<.001
Multivariate RR (95% CI)†	1.00	1.09 (0.85-1.39)	1.30 (1.03-1.63)	1.44 (1.12-1.85)	1.70 (1.20-2.43)	<.001

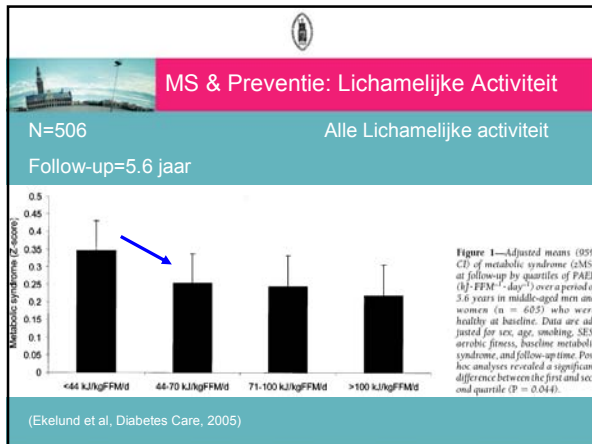
(Hu et al, JAMA, 2003)

MS & Preventie: Sedentaire Leefstijl

(Hu et al, JAMA, 2003)

Dia 1

A1 Administrator; 26-9-2007



MS & Preventie: Lichamelijke Activiteit

N=5153
Self-reported leisure time physical activity

Table 4 Odds ratios (and 95% CI) for metabolic syndrome for vigorous activity (n = 4945) and moderate activity adjusted for body mass index (BMI) and resting heart rate (HR)^a (n = 2722).

Model	Base	Base + BMI	Base + HR	Base + BMI + HR
Vigorous activity category MET h/week				
None (n = 2722)	1	1	1	1
<5 (n = 192)	0.70 (0.52, 0.94)	0.88 (0.65, 1.21)	0.75 (0.55, 1.01)	0.91 (0.67, 1.23)
6–12.5 (n = 718)	0.77 (0.59, 1.00)	0.84 (0.71, 1.26)	0.84 (0.65, 1.10)	1.01 (0.76, 1.34)
>12.5 (n = 913)	0.53 (0.41, 0.69)	0.64 (0.47, 0.85)	0.61 (0.47, 0.80)	0.69 (0.51, 0.92)
P for trend	<0.001	0.005	<0.001	0.01
Moderate activity category MET h/week				
<24 (n = 1349)	1	1	1	1
≥24 (n = 1373)	0.78 (0.63, 0.98)	0.84 (0.66, 1.07)	0.82 (0.65, 1.02)	0.88 (0.69, 1.12)
P-value	0.03	0.16	0.08	0.29

Only those who reported no vigorous activity included in the moderate activity analyses Base+sex, age, smoking, high alcohol intake, and grade into moderate activity in vigorous activity models.

(Rennie et al, Int J Epidemiology, 2003)

MS & Preventie: Lichamelijke Activiteit

No. of cases	Person-years	Relative risk* (95% confidence interval)		
		Model 1	Model 2	Model 3
Occupational physical activity				
Light	67250	1.00	1.00	1.00
Moderate	48184	0.57 (0.43-0.76)	0.66 (0.49-0.90)	0.70 (0.52-0.96)
Active	55695	0.76 (0.60-0.97)	0.73 (0.56-0.94)	0.74 (0.57-0.95)
p value for trend		< 0.001	0.008	0.020
Walking or traveling to/from work				
0 min/d	242	1.00	1.00	1.00
1-29 min/d	93	0.75 (0.59-0.96)	0.88 (0.68-1.15)	0.96 (0.74-1.25)
≥ 30 min/d	38	0.42 (0.30-0.59)	0.54 (0.38-0.77)	0.64 (0.45-0.92)
p value for trend		< 0.001	0.003	0.048
Leisure-time physical activity				
Low	56387	1.00	1.00	1.00
Moderate	88350	0.63 (0.50-0.78)	0.67 (0.53-0.84)	0.81 (0.61-1.02)
Active	26392	0.52 (0.36-0.75)	0.61 (0.41-0.90)	0.84 (0.57-1.25)
p value for trend		< 0.001	0.001	0.186

*Model 1, adjusted for age, sex, and study year; Model 2, adjusted for the factors in Model 1, plus systolic blood pressure, smoking status, education, and the 2 other kinds of physical activity; Model 3, adjusted for the factors in Model 2, plus body mass index.

(Hu et al, Appl Physiol Nutr Metab 2007; 32:583-595)

MS & Preventie: Lichamelijke Activiteit

- UPLIFT Studie (N=1440) – Lichamelijke Activiteit

↓

Metabool Syndroom (NCEP ATP III richtlijnen)

Vanhees et al, 2007 (unpublished)

Afhankelijke variabelen	Metabool syndroom JA	Metabool syndroom NEE	Totaal (N)
Leeftijd (jaars)	44.5 ± 0.62***	37.7 ± 0.35	40.4 ± 0.51
Geslacht			
Man/vrouw (%)	80/19.9***	65/34.7	772
Man/vrouw (n)	165/41	607/222	363
Roker	27.7% (n=56)*	20.9% (n=191)	247
Ex-roker	46.0% (n=92)**	33.3% (n=281)	363
Functie			
Executief (%)	70.4% (n=145)	75.5% (n=701)	846
Administratief (%)	29.6% (n=61)	24.5% (n=226)	288
Activiteiten			
Hoofdelheid (min/week)	2000 ± 80.9*	2208 ± 26.1	2198 ± 60.0
Gem. intensiteit (MET/h)	3.09 ± 0.02*	3.01 ± 0.02	3.05 ± 0.025
Sport			
Hoofdelheid (min/week)	151 ± 22.0*	220 ± 13.7	186 ± 17.9
Gem. intensiteit (MET/h)	3.79 ± 0.24***	5.08 ± 0.11	4.44 ± 0.18
Sport + activiteit			
Hoofdelheid (min/week)	2236 ± 85.0**	2508 ± 41.7	2372 ± 63.4
Gem. intensiteit (MET/h)	3.32 ± 0.05	3.39 ± 0.03	3.36 ± 0.04

Waarden weergegeven als % (n) of gemiddelde ± SE.
Executief: executief operationeel, executief ondernemend, leidgend, uitvoerend. Administratief: administratief operationeel, administratief ondernemend, administratief uitvoerend.

MS & Lichamelijke activiteit

- UPLIFT Studie (N=1440) – Lichamelijke Activiteit

↓

Metabool Syndroom (NCEP ATP III richtlijnen)

Vanhees et al, 2007 unpublished

Tabel 4: De β -coëfficiënt en partiële R² van de regressies tussen het metabool syndroom en de hoeveelheid en de gemiddelde intensiteit van de activiteiten en de sportbeoefening.

	Hoofdelheid (min/week)		
	Activiteit	Sport	Totaal
Univariate	-0.0002 (0.0044)*	-0.0006 (0.0041)**	-0.00028 (0.0075)**
Correctie leeftijd, gesl	-0.00023 (0.0063)*	-0.00004 (0.0016)	-0.00026 (0.0064)**
Correctie leeftijd, gesl, admin	-0.00003 (0.0091)*	-0.00003 (0.0114)	-0.00028 (0.0050)**
Partiële R ²	0.0001	0.0001	0.0001
Gemiddelde intensiteit (MET/h)			
	Activiteit	Sport	Totaal
Univariate	0.009 (0.0045)*	-0.0183 (0.0236)***	-0.0204 (0.0014)
Correctie leeftijd, gesl	0.0087 (0.0022)	-0.0121 (0.0191)**	-0.0071 (0.0017)
Correctie leeftijd, gesl, admin	0.0019 (0.0033)	-0.0118 (0.0098)***	-0.0047 (0.0050)***
Partiële R ²	0.0019	0.0019	0.0019

Waarden zijn gepresenteerd als β -coëfficiënt (partiele R²).
Min/week, minuten per week; leeftijd, geslacht, admin, functie; gemidd. gemiddelde.

MS & Lichamelijke activiteit

- UPLIFT Studie (N=1440) – Lichamelijke Fitheid

↓

Metabool Syndroom (NCEP ATP III richtlijnen)

Vanhees et al, 2007 unpublished

Afhankelijke variabelen	Metabool syndroom Ja	Metabool syndroom nee
leeftijd	45 ± 10***	38 ± 11
geslacht vrouw (%)	19,9***	34,7
Roker (%)	27,7*	20,8
Ex-roker (%)	46,0***	33,3
Functie executief (%)	70,4	75,5
Functie administratief (%)	29,6	24,5
VO2 max (ml/min)	2807 ± 720	2849 ± 771
VO2max/ kg LG	30,6 ± 7,5***	36,4 ± 7,9
Sedentaire waarden	105 ± 19**	112 ± 26
Hfmax	163 ± 16***	170 ± 14

MS & Lichamelijke activiteit

- UPLIFT Studie (N=1440)
 - Lichamelijke Fitheid

↓

Metabool Syndroom (NCEP ATP III richtlijnen)

Vanhees et al, 2007 unpublished

Totaal	VO2max		VO2max/kg		Sed. Wandel	
	P.E.	P	P.E.	P	P.E.	P
Uniektaat	-0,0001088 (0,001)		-0,0126 (0,014)**		-0,0016 (0,011)**	
Correctie voor leeftijd, geslacht, lengte en gewicht	-0,007042 (0,002)**		-0,0067 (0,002)**		-0,0034 (0,008)**	
Correctie voor leeftijd, geslacht, lengte en gewicht en adolinesuiker	-0,007042 (0,002)**		-0,0067 (0,002)**		-0,0034 (0,008)**	

MS & Lichamelijke Activiteit

- Preventie:
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- Behandeling
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MS & Behandeling

- Effect op:
 - Risicofactoren (bloeddruk, lipiden, obesiteit, glucose intolerantie of insuline sensitiviteit)
 - Metabool Syndroom (combinatie risicofactoren)

Behandeling MS - Risicofactoren

- Meta-Analyses
 - Obesiteit
 - Insuline sensitiviteit
 - Dyslipidemie
 - Hypertensie

Risicofactoren – Obesiteit: Fysieke training vs Controle

(Shaw et al. Cochrane Library, 2006)

Study	Exercise		No treatment		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)		
Stefanick 1998	U	90	-0,50 (2,80)	91	0,65 (3,50)	-1,15 [-2,07, -0,23]
Thong 2000	U	16	-7,60 (0,40)	8	-0,10 (0,80)	-7,50 [-8,09, -6,91]
Wood 1988	U	47	-4,00 (3,90)	42	0,60 (3,70)	-4,60 [-6,18, -3,02]

-100 -50 0 50 100
Favours exercise Favours no treatment

Weighted Mean Difference (Fixed) 95% CI

Δ Gewicht (kg)

Study	Exercise		No treatment		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)		
Andersen 1996	U	49	-0,65 (1,50)	43	0,36 (0,80)	-1,01 [-1,49, -0,53]
Hellenius 1993	U	39	-0,30 (0,80)	39	0,30 (0,64)	-0,60 [-0,92, -0,28]
Thong 2000	U	16	-2,40 (0,40)	8	-0,03 (0,30)	-2,37 [-2,66, -2,08]

-100 -50 0 50 100
Favours exercise Favours no treatment

Weighted Mean Difference (Fixed) 95% CI

Δ BMI

U= Uithoudingstraining; K= Krachttraining; U/K= 2 aparte trainingsgroepen; U&K= combinatietraining

Risicofactoren – Obesiteit: Fysieke training vs Dieet

Study	Exercise		Diet		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)		
Andersen 1996	U	49	-0,65 (1,50)	43	-0,40 (0,80)	0,25 [-0,31, 0,29]
Hellenius 1993	U	39	-0,30 (0,80)	40	-0,30 (0,60)	0,00 [-0,40, 0,40]
Thong 2000	U	16	-2,40 (0,40)	14	-3,10 (0,80)	0,70 [-0,46, 0,46]
Wing 1988	U	33	0,80 (1,50)	26	-3,20 (2,30)	-4,00 [-4,41, -3,59]

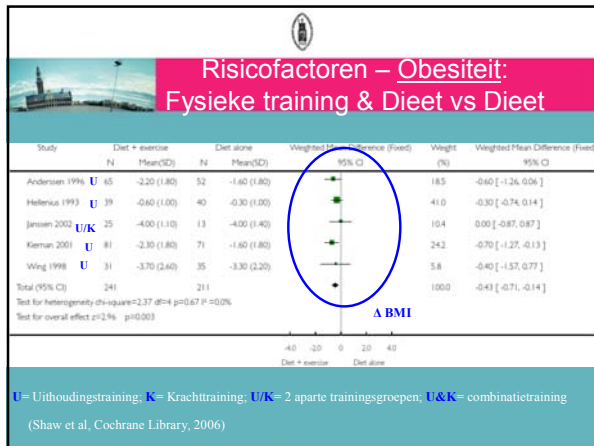
-100 -50 0 50 100
Favours exercise Favours diet

Weighted Mean Difference (Fixed) 95% CI

Δ BMI

U= Uithoudingstraining; K= Krachttraining; U/K= 2 aparte trainingsgroepen; U&K= combinatietraining

(Shaw et al. Cochrane Library, 2006)



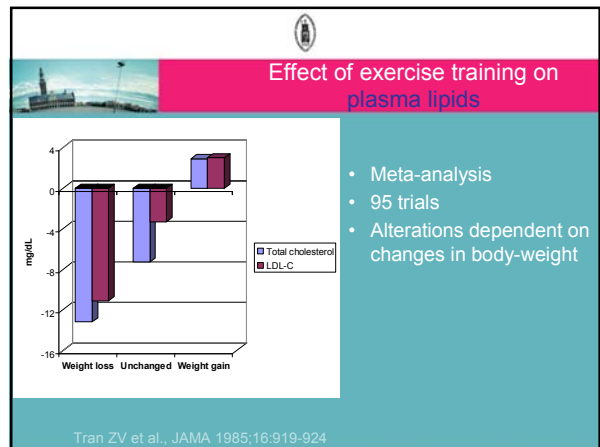
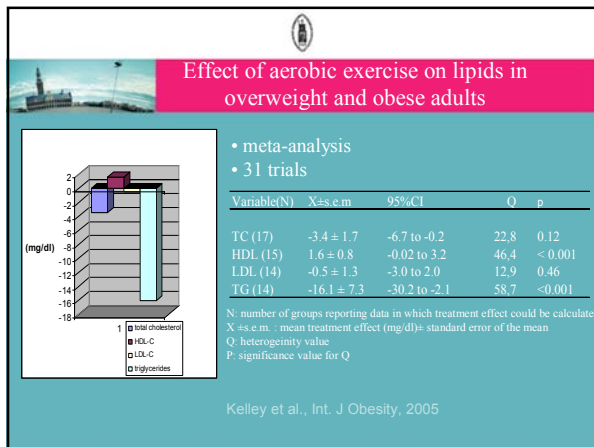
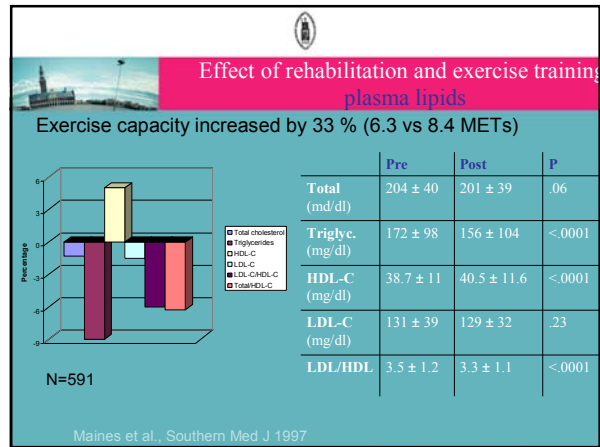
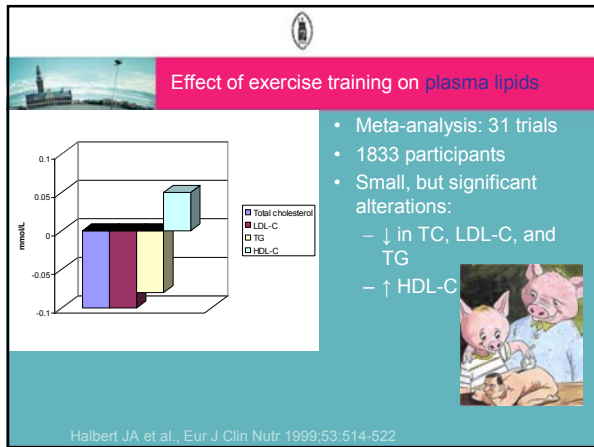
Risicofactoren – Dyslipidemie:

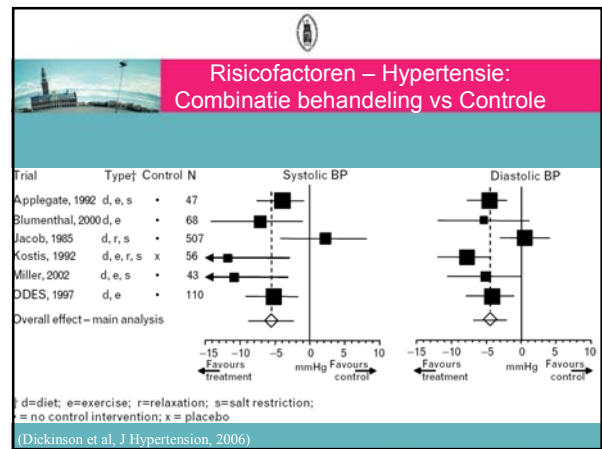
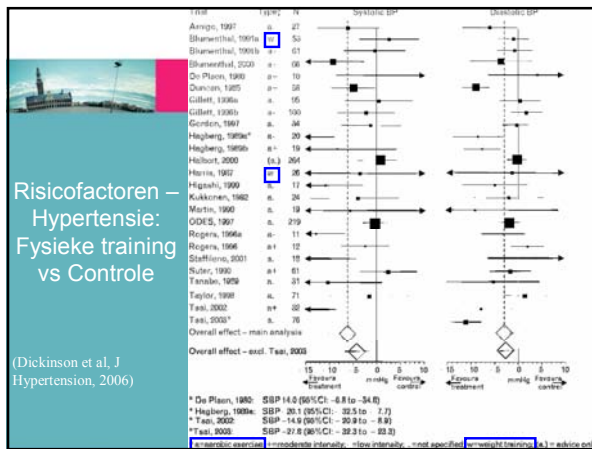
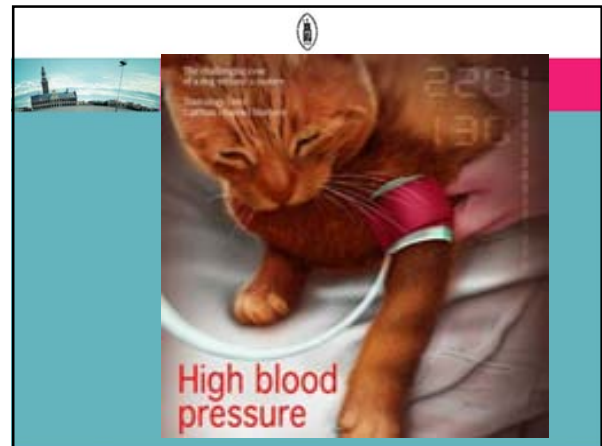
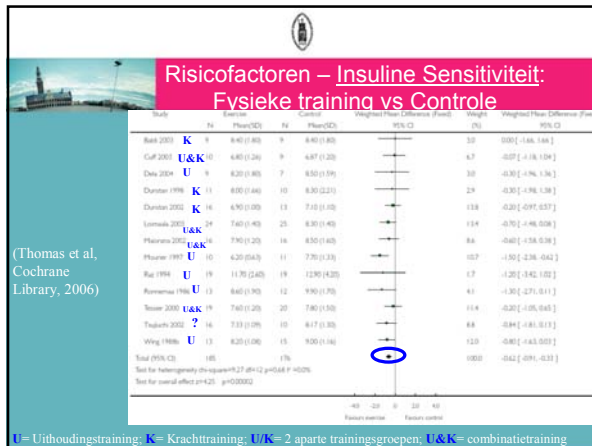
Table 2. Effect of exercise (aerobic and resistance) training on the blood lipid profile

	Training group	Control group	Change in blood lipid (mmol/L) (95% CI)	WMD (95% CI Random)
number of studies = 31)				
TC	527	614	0.10 (0.02, 0.18)	
HDL-C	982	842	-0.05 (-0.08, -0.02)	
LDL-C	843	742	0.10 (0.02, 0.19)	
TG	907	792	0.08 (0.02, 0.14)	
number of studies = 4*)				
TC	92	65	0.06 (-0.26, 0.37)	
HDL-C	75	56	-0.05 (-0.19, 0.10)	
LDL-C	75	56	0.40 (0.07, 0.73)	
TG	79	57	-0.03 (-0.16, 0.09)	

Change expressed as mean change in training Group - mean change in control Group when change is baseline - final lipid values. Weighted mean difference (95% CI Random). *Hershey (1994) included both aerobic and resistance training groups.

(Halbert, Eur J Clin Nutr, 1999)





Effect of exercise training on blood pressure

Baseline data and net changes in response to dynamic exercise training

	N	Baseline		Net change		P
		Mean (95% CL)	Mean (95% CL)	Mean (95% CL)	P	
Blood pressure (mmHg)						
Systolic	68	126.2 (123.3; 129.0)	-3.4 (-4.5; -2.3)	<0.001		
Diastolic	68	79.9 (77.9; 82.0)	-2.4 (-3.2; -1.6)	<0.001		
Peak oxygen uptake (ml/min/kg)	59	31.4 (29.6; 33.2)	+3.7 (+3.2; +4.3)	<0.001		
Heart rate (beats/min)	48	71.1 (69.3; 72.9)	-4.9 (-5.9; -3.9)	<0.001		
Body mass index (kg/m)	64	25.6 (25.0; 26.1)	-0.34 (-0.46; -0.22)	<0.001		

Values are weighted means and 95% confidence limits (CL).
N: # training groups programs

Meta-analysis by Fagard et al. Journal of human hypertension, 2005

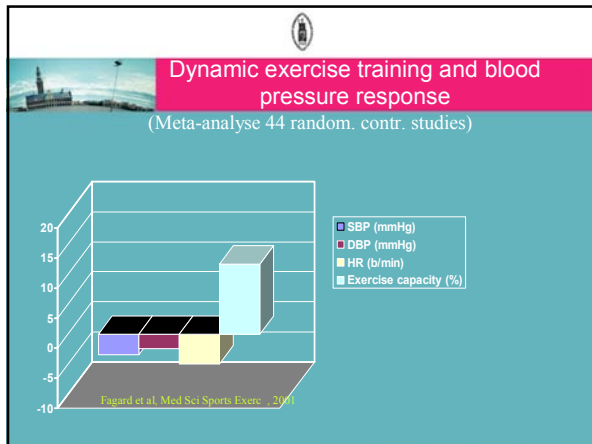
Effect of exercise training on blood pressure (haemodynamic data)

Net haemodynamic changes (%) in response to exercise training

	N	Mean (95% CL)	P
Mean blood pressure	17	-4.9 (-7.0; -2.7)	<0.001
Cardiac output	17	+1.4 (-4.7; +7.5)	NS
Heart rate	16	-9.1 (-13.0; -5.2)	<0.001
Stroke volume	15	+14.9 (+5.6; +24.2)	<0.01
Systemic vascular resistance	17	-7.4 (-13.2; -1.6)	<0.05

Values are weighted means and 95% confidence limits (CL).
N=number of study groups.
NS=not significant.

Meta-analysis by Fagard et al. Journal of human hypertension, 2005



Dynamic exercise training and blood pressure response

(in normotensives and hypertensives)

	Normotensives (n = 210)	Hypertensives (n = 138)	H vs N
Systole	- 3 (+0.5 to -7)	- 13 (-11 to -15)	- 10 (-7 to -12)
Diastole	- 2 (+ 1 to -5)	- 8 (-6 to -10)	- 6 (-5 to -6)

(values are weighted means (95% CL) of 7 studies)

Fagard et al. Handbook of Hypertension, Vol 20: Epidemiology of Hypertension, 2000

Lifestyle changes in the treatment of hypertension

Lifestyle change	Effect on systolic BP
Weighth loss	5 – 10 mmHg/10 kg
DASH-diet	8 – 14 mmHg
Salt restriction	2 – 8 mmHg
Physical activity	4 – 9 mmHg
Moderate alcohol use	2 – 4 mmHg

Chobanian et al. Hypertension, 2003

Determinants of blood pressure response to exercise

Training mode

Endurance training Versus Resistance training

- ### Training mode
- Effect of endurance training on blood pressure: meta-analysis by Cornelissen et al. Hypertension, 2005
 - Effect of resistance training on blood pressure: meta-analysis by Cornelissen et al., Journal of Hypertension, 2005
 - Effect of (isometric) strength training on BP measured in various conditions in sedentary men: Van Hoof et al., Int. J sport med, 1996

Effect of endurance training on VO2max and HR

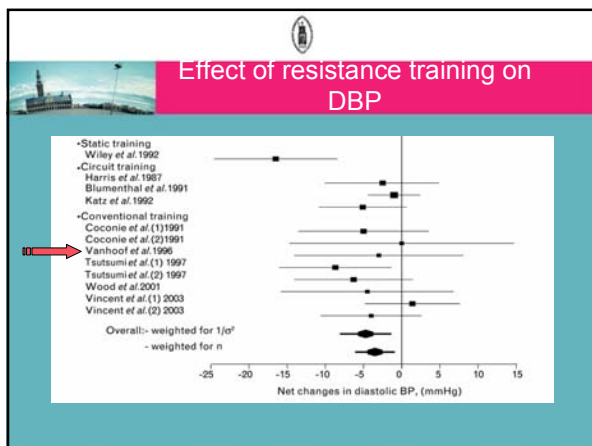
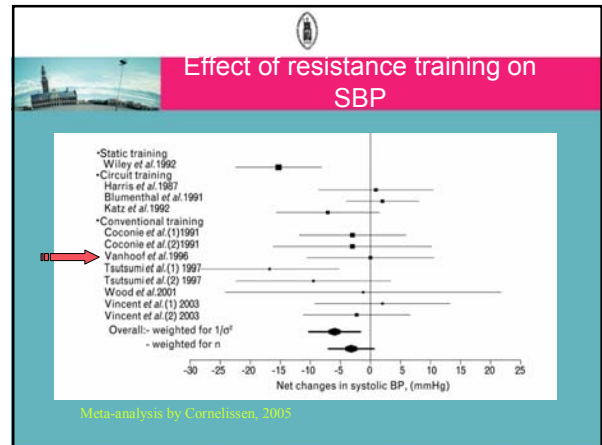
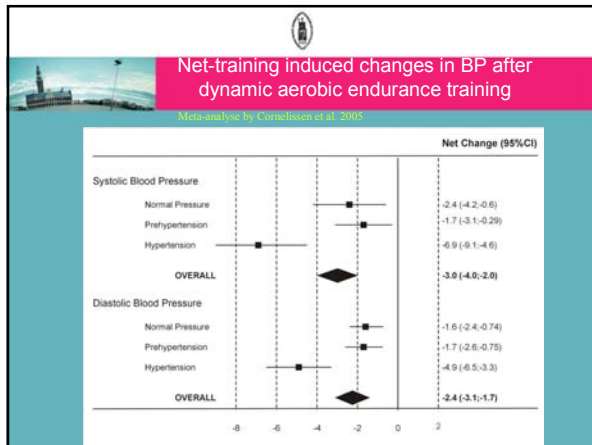
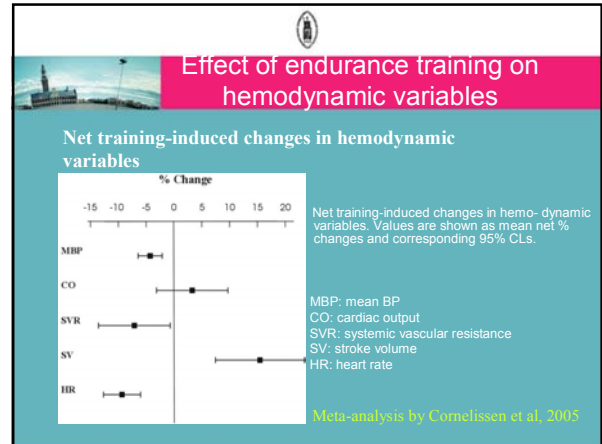
Variable	Subgroup	N studies	Baseline	Net Change	P Value
VO ₂ max	Normal pressure	25	31.6 (28.9; 34.3)	3.5 (2.5; 4.4)	<0.001
	Pre-hypertension	39	31.5 (29.5; 33.4)	3.9 (3.1; 4.6)	<0.001
	Hypertension	17	29.2 (25.6; 32.8)	4.4 (3.7; 5.1)	<0.001
HR	Normal pressure	18	71.0 (67.1; 74.9)	-7.1 (-9.3; -5.0)	<0.001
	Hypertension	23	74.4 (72.4; 76.3)	-4.5 (-6.5; -2.6)	0.001

Cornelissen, 2005

Effect of endurance training on BP

variable	subgroups	N studies	baseline	net changes	P value
SBP	Normal pressure	28	114.3 (112.8; 115.9)	-2.4 (-4.2; -0.6)	<0.01
	Prehypertension	46	127.2 (125.9; 128.5)	-1.7 (-3.1; -0.29)	<0.05
	Hypertension	30	145.4 (142.4; 148.4)	-6.9 (-9.1; -4.6)	<0.001
DBP	Normal pressure	28	73.0 (71.8; 74.1)	-1.6 (-2.4; -0.75)	<0.001
	Prehypertension	44	80.3 (79; 81.6)	-1.7 (-2.6; -0.75)	<0.001
	Hypertension	30	92.3 (89.5; 95.1)	-4.9 (-6.5; -3.3)	<0.001

Cornelissen, 2005



Effect of resistance training

Variable	Baseline		Net change		P value
	N	Mean (95% CL)	N	Mean (95% CL)	
Blood pressure (mmHg)					
weighted for $1/\sigma^2$					
Systolic	12	131.6 (123.5-139.6)	12	-6.0 (-10.4 to -1.6)	< 0.01
Diastolic	12	80.9 (73.9-87.8)	12	-4.7 (-8.1 to -1.4)	< 0.01
weighted for n					
Systolic	12	131.0 (123.0-138.8)	12	-3.2 (-7.1 to +0.7)	= 0.10
Diastolic	12	81.1 (74.5-87.7)	12	-3.5 (-6.1 to -0.9)	< 0.01
VO ₂ max (ml/min per kg)	9	24.7 (19.2-30.2)	6	+2.6 (+0.3 to +4.8)	< 0.05
Heart rate (beats/min)	10	70.7 (66.9-74.4)	8	+1.0 (-1.7 to +3.7)	NS
Percent body fat (%)	6	30.1 (27.7-32.5)	4	-0.94 (-1.6 to -0.25)	< 0.01
Weight (kg)	8	76.4 (69.4-83.4)	4	+0.33 (-2.7 to +3.4)	NS

N, number of trials; n, number of trained participants; VO₂, oxygen uptake. Values are given as weighted mean and 95% confidence limits (CL).

Cornelissen, 2005

Effect of strength training on BP measured in various conditions in sedentary men.

- 30 sedentary men
- Training group <-> control group
- 48 training sessions, 3X/week
- As static or isometric exercise as possible

Van Hoof et al., Int. J. Sports Med. 17 (1996)

Effect of strength training on BP measured in various conditions in sedentary men.

- Strength training affected muscle strength: 1RM values of the various ex. muscles increased significantly
- Strength training did not affect VO₂Max, BP, HR or lipids

Van Hoof et al., Int. J. Sports Med. 17 (1996)

MS & Behandeling

- Effect op:
 - Risicofactoren (bloeddruk, lipiden, obesiteit, insuline resistentie)
 - **Metabool Syndroom** (combinatie risicofactoren)

MS behandeling: fysieke activiteit

Targeting the Metabolic Syndrome with Exercise: Evidence from the HERITAGE Family Study

KATZMARZYK PT, LEON AS, WILMORE JH, SKINNER JS, RAO DC, RANKINEN T, BOUCHARD C, Med Sci Sports Ex, 2003

MS behandeling: fysieke activiteit

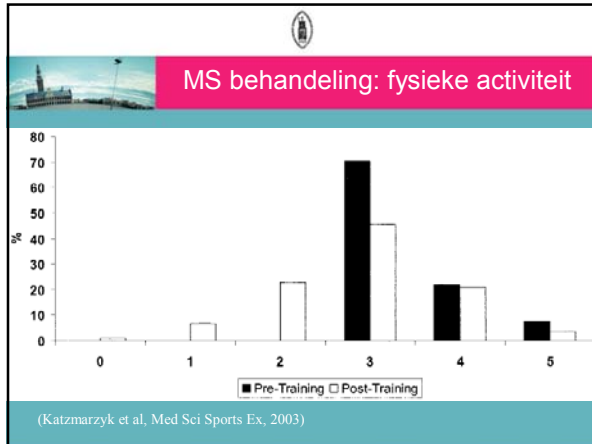
- RCT
- N=621 (sedentair, schijnbaar gezond)
- MS= aanwezigheid ≥ 3 risicofactoren
- Aerobe training= 20 weken onder toezicht
- 3x/week; 30-50 min

(Katzmarzyk et al, Med Sci Sports Ex, 2003)

MS behandeling: fysieke activiteit

(Katzmarzyk et al, Med Sci Sports Ex, 2003)

FIGURE 1—Prevalence of individual risk factors before and after 20 wk of aerobic exercise training in the HERITAGE Family Study among 105 participants with the metabolic syndrome at baseline. *P < 0.05 pre- versus posttraining.



MS behandeling: fysieke activiteit

Exercise and Risk Factors associated with Metabolic Syndrome in Older Adults

KJ Stewart, AC Bacher, K Turner, JG Lim, PS Hees, EP Shapiro, M Tayback, P Ouyang, Am J Prev Med, 2005

MS behandeling: fysieke activiteit

- RCT
- N=115 (55-75 jaar; sedentair)
- 6 maanden training
 - 3x/week
 - Combinatie: Krachttraining (10-15 repetities; 50% 1RM) & Uithoudingstraining (45 min; 60-90% HR max)

(Stewart et al., Am J Prev Med, 2005)

Table 1. Baseline characteristics of randomized participants in RCT (n=115)

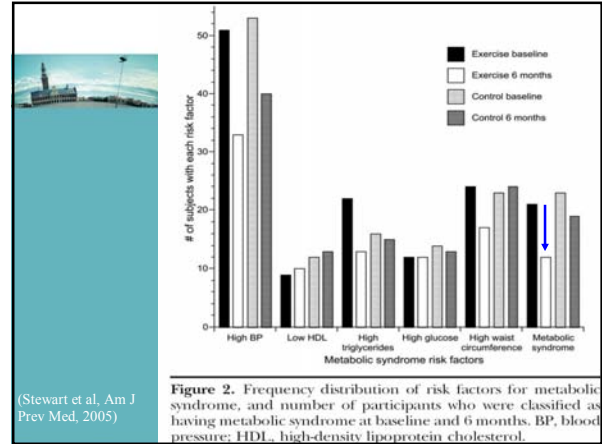
	Exercise	Control	p value*
Age (years)	59.9 (33.2-84.2)	58.1 (52.1-62.5)	0.55
Aerobic and strength fitness (mean, 95% CI)			
Peak oxygen uptake, ml/kg/min	21.8 (20.6-23.0)	24.1 (22.8-25.7)	0.08
1RM muscle strength†	122.1 (114.2-130.1)	125.6 (116.3-134.9)	0.97
Body composition, mean (95% CI)			
Body mass index	27.4 (26.7-28.1)	28.2 (26.5-29.9)	0.75
Weight, kg	85.2 (81.1-89.2)	88.5 (81.8-95.2)	0.53
Waist circumference, cm	94.9 (93.6-96.2)	95.0 (91.1-98.9)	0.60
Waist:hip ratio	0.9 (0.9-0.9)	0.9 (0.9-0.9)	0.75
Abdominal visceral fat (MRI), cm ³	492.5 (329.5-655.5)	402.8 (274.2-531.5)	0.26
Abdominal subcutaneous fat (MRI), cm ³	146.8 (127.8-165.7)	147.2 (115.2-179.2)	0.77
Abdominal subcutaneous fat (DEXA), cm ³	255.1 (204.4-305.8)	257.7 (208.9-306.5)	0.36
Total body fat (DEXA), %	32.8 (31.4-34.2)	33.2 (32.4-34.0)	0.66
Lean body mass (DEXA), %	67.2 (65.8-68.6)	66.8 (66.0-67.6)	0.56
Resting blood pressure, mean (95% CI)			
Systolic blood pressure, mm Hg	116.3 (115.0-117.6)	110.1 (109.7-110.5)	0.01
Diastolic blood pressure, mm Hg	76.0 (74.6-77.5)	75.4 (73.1-77.8)	0.72
Lipids and lipoprotein, mean (95% CI)			
Cholesterol, mg/dl	212.9 (209.9-215.9)	207.1 (198.8-215.4)	0.16
High-density lipoprotein cholesterol, mg/dl	55.5 (53.4-57.6)	55.1 (51.1-59.2)	0.27
Low-density lipoprotein cholesterol, mg/dl	155.4 (153.1-157.7)	152.0 (147.6-156.4)	0.75
Very low-density lipoprotein cholesterol, mg/dl	25.5 (24.0-27.0)	25.7 (24.1-27.3)	0.48
Triglycerides, mg/dl	106.1 (101.5-110.7)	107.5 (95.7-119.3)	0.47
Lipoprotein(a), mg/dl	22.9 (21.1-24.7)	23.5 (21.2-25.8)	0.46
Glucose and insulin, mean (95% CI)			
Glucose, mg/dl	100.3 (97.7-102.9)	107.1 (104.4-109.8)	0.16
Insulin, mIU/ml	10.7 (10.2-11.2)	9.8 (9.2-10.4)	0.21
HOMA-IR	9.56 (9.39-9.74)	8.91 (8.33-9.50)	0.57
Metabolic syndrome risk factors			
Number of metabolic risk factors	2.5 (2.0-3.0)	2.6 (2.0-3.2)	0.98
Diagnosed with metabolic syndrome (%)	49.4 (37-62)	61.8 (47-76)	0.25
CHD risk index, mean (95% CI)†	10.9 (10.3-11.5)	12.1 (11.2-13.0)	0.12

*p < 0.05 (bilateral), **p < 0.01 (bilateral), ***p < 0.001 (bilateral).
†Indicates linear CHD risk.
‡Indicates linear CHD risk.
§Indicates linear CHD risk.
¶Indicates linear CHD risk.

Table 2. Change in study variables from baseline in exercise and control participants

	Exercise	Control	Difference	p value*
Aerobic and strength fitness (mean, 95% CI)				
Peak oxygen uptake, ml/kg/min	4.0 (3.2-4.8)	-0.1 (-0.8-0.5)	4.1 (3.1-5.2)	<0.001***
Total muscle strength, lb	126.0 (109.1-142.4)	8.0 (-5.8-21.8)	118.1 (96.9-139.2)	<0.001***
Body composition, mean (95% CI)				
Body mass index [†]	-0.8 (-1.1-0.5)	-0.2 (-0.6-0.1)	-0.7 (-1.1-0.3)	<0.001***
Weight, kg	-2.3 (-3.1-1.4)	-0.5 (-1.2-0.1)	-1.7 (-2.8-0.7)	<0.002**
Waist circumference, cm	-2.9 (-4.1-1.7)	-0.8 (-1.8-0.1)	-2.0 (-3.6-0.5)	0.01*
Waist:hip ratio	-0.01 (-0.02-0.00)	-0.01 (-0.01-0.00)	0.00 (-0.01-0.01)	0.52
Abdominal total fat (MRI), cm ³	-52.5 (-66.6-38.7)	-6.5 (-20.3-7.5)	-46.0 (-65.4-26.5)	<0.001***
Abdominal visceral fat (MRI), cm ³	-26.7 (-33.6-17.9)	-3.8 (-10.8-3.3)	-22.9 (-34.2-11.8)	<0.001***
Abdominal subcutaneous fat (MRI), cm ³	-25.8 (-35.1-16.5)	-2.9 (-11.5-5.6)	-22.9 (-35.7-10.3)	<0.001***
Total body fat (DEXA), %	-3.5 (0.0-2.8)	-0.2 (0.5-0.5)	-3.3 (-4.1-2.4)	<0.001***
Lean body mass (DEXA), %	3.5 (2.8-4.2)	0.2 (-0.3-0.7)	3.3 (2.4-4.1)	<0.001***
Resting blood pressure, mean (95% CI)				
Systolic blood pressure, mm Hg	-5.3 (-8.1-2.5)	-4.5 (-6.7-2.2)	-0.8 (-4.8-3.2)	0.65
Diastolic blood pressure, mm Hg	-3.7 (-5.1-2.4)	-1.5 (-2.9-0.2)	-2.2 (-4.1-0.3)	0.02*
Heart rate, bpm	-3.9 (-5.4-2.4)	-2.2 (-3.8-0.5)	-1.8 (-4.1-0.5)	0.12
Lipids and lipoprotein, mean (95% CI)				
Cholesterol, mg/dl	-5.2 (-13.3-3.0)	-5.3 (-14.2-3.7)	0.0 (-1.2-12.0)	0.99
High-density lipoprotein cholesterol, mg/dl	3.0 (1.3-4.9)	-0.3 (-2.3-1.5)	3.3 (0.7-5.9)	0.01*
Low-density lipoprotein cholesterol, mg/dl	-5.7 (-12.5-1.2)	-5.1 (-13.3-5.0)	-0.6 (-11.6-10.5)	0.92
Very low-density lipoprotein cholesterol, mg/dl	-4.0 (-7.8-0.4)	0.2 (-2.4-2.8)	-4.2 (-8.6-0.3)	0.07
Triglycerides, mg/dl	-13.4 (-33.9-6.9)	1.2 (-11.9-14.2)	-14.6 (-40.3-11.1)	0.26
Lipoprotein(a), mg/dl	-0.9 (-3.2-1.4)	1.8 (-2.9-6.5)	-2.7 (-7.9-2.5)	0.30
Glucose and insulin, mean (95% CI)				
Glucose, mg/dl	0.2 (-2.7-3.0)	1.7 (-1.5-5.0)	-1.5 (-2.8-5.0)	0.40
Insulin, mIU/ml	-0.6 (-1.8-0.5)	-0.1 (-1.2-1.0)	-0.6 (-2.5-1.4)	0.56
HOMA-IR	0.00 (0.00-0.01)	0.00 (-0.01-0.01)	0.01 (-0.01-0.01)	0.21
CHD risk index, mean (95% CI)†	-1.0 (-1.8-0.2)	-0.3 (-1.1-0.6)	-0.8 (-0.4-1.9)	0.18

*p < 0.05 (bilateral), **p < 0.01 (bilateral), ***p < 0.001 (bilateral).
†Indicates linear CHD risk.
‡Indicates linear CHD risk.
§Indicates linear CHD risk.
¶Indicates linear CHD risk.



MS behandeling: fysieke activiteit

Can Adoption of Regular Exercise Later in Life Prevent Metabolic Risk for Cardiovascular Disease?

Petrella RJ, Lattonzio CN, Demeray A, Varallo V, Blore R.
Diabetes Care, 2005

MS behandeling: fysieke activiteit

- RCT
- N=420 (55-75 jaar)
- Uithoudingstraining, 3x/week, 30-45 min, 75-85% VO₂max
- Inspanningstest:
 - Baseline
 - Jaarlijks gedurende 10 jaar
 - Inclusie: 80% van alle trainingssessies gevolgd (jaarlijks)

(Petrella et al, Diabetes Care, 2005)

MS behandeling: fysieke activiteit

Table 2—Percent change in metabolic indices between 1987 and 1997 for the active and sedentary men and women

	Active				Sedentary				P
	Baseline	Follow-up	ΔB - F	%Δ	Baseline	Follow-up	ΔB - F	%Δ	
BMI (kg/m ²)	27.3 ± 0.2	27.2 ± 0.4	-0.1	-0.37	27.6 ± 0.4	28.9 ± 0.3	+1.3	1.09	NS
BP (mmHg)	129 ± 7	135 ± 5	+6	+4.65	131 ± 8	141 ± 5	+10	7.63	<0.001
Glucose (mmol/L)	5.6 ± 1.4	5.8 ± 1.2	+0.2	+3.57	5.6 ± 1.7	5.8 ± 1.3	+0.2	3.57	NS
Total cholesterol (mmol/L)	5.4 ± 1.6	5.4 ± 1.4	+0.1	-0.06	5.3 ± 1.3	5.3 ± 1.3	+0.2	3.77	<0.05
LDL cholesterol (mmol/L)	2.6 ± 0.7	2.7 ± 1.0	+0.1	3.85	2.9 ± 0.9	3.1 ± 1.2	+0.2	6.89	<0.02
HDL cholesterol (mmol/L)	1.1 ± 0.3	1.2 ± 0.8	+0.1	+9.09	1.1 ± 0.3	0.9 ± 0.8	-0.2	-18.18	<0.001
Triglycerides (mmol/L)	2.14 ± 1.1	1.96 ± 1.6	-0.18	-8.41	2.2 ± 1.2	2.9 ± 1.4	+0.7	31.82	<0.001
Insulin (pmol/L)	276 ± 200	273 ± 212	-3	-1.09	311 ± 234	299 ± 230	-12	-3.86	<0.05
HOMA-IR	6.86 ± 2	7.04 ± 0.8	+0.18	+6.04	7.71 ± 0.40	7.74 ± 0.33	+0.03	+4.6	NS
Waist circumference (cm)	92.5 ± 4.5	94.5 ± 5.5	+2	2.12	90.5 ± 6.3	101.3 ± 9.5	+10.8	10.66	<0.001
METS	5.7 ± 0.8	5.9 ± 0.9	+0.2	3.51	5.8 ± 1.0	5.0 ± 1.0	-0.8	-13.79	<0.001

Data are means ± SD. ΔB - F, absolute baseline minus follow-up; %Δ, percent change from baseline to follow-up.

(Petrella et al, Diabetes Care, 2005)

MS & Lichamelijke Activiteit

- Preventie:
 - Relatie tussen fysieke (in)activiteit en metabool syndroom
- Behandeling
 - Effecten
 - Soort training?
 - Conclusie
- Aanbevelingen

Soort Training?

- Meta-analyses:
 - Bijna uitsluitend Uithoudingstraining

Wat met Krachttraining?

Soort Training?

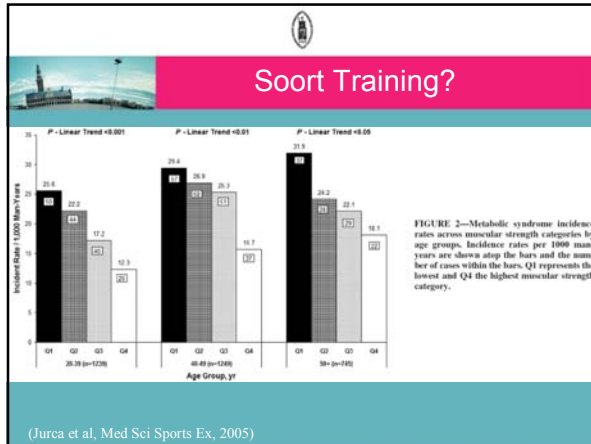
N=3233 (20-80 jaar) ; Follow-up= 6.7±5.2 jaar; Incidentie MS: 480

TABLE 2. Metabolic syndrome incident rates and hazard ratios by muscular strength categories in 3233 men in the Aerobics Center Longitudinal Study (1980–2003).

	Muscular Strength				P Value for Trend
	Q1 (Low)	Q2	Q3	Q4 (High)	
Participants (N)	808	809	808	808	
Man-years of follow-up	5129	5289	5002	5055	
Cases (N)	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	0.95 (0.73–1.21)	0.89 (0.70–1.13)	0.66 (0.50–0.88)	0.004
HR (95% CI), Model 3‡	1.00	0.96 (0.73–1.21)	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.

(Jurca et al, Med Sci Sports Ex, 2005)



Soort Training?

Krachttraining als behandeling?

(Braith et al, Circulation, 2006)

Variable	Aerobic Exercise	Resistance Exercise
Bone mineral density	↑	↑ ↑ ↑
Body composition		
Fat mass	↓ ↓	↓
Muscle mass	↑ ↑	↑ ↑
Strength	↑ ↑	↑ ↑ ↑
Glucose metabolism		
Insulin response to glucose challenge	↓ ↓	↓ ↓
Basal insulin levels	↓	↓
Insulin sensitivity	↑ ↑	↑ ↑
Serum lipids		
High-density lipoprotein	↑ ↑	↑ ↑
Low-density lipoprotein	↓ ↓	↓ ↓
Resting heart rate	↓ ↓	↓ ↓
Blood pressure at rest		
Systolic	↓ ↓	↓
Diastolic	↓ ↓	↓
Physical endurance	↑ ↑ ↑	↑ ↑
Basal metabolism	↑	↑ ↑

↑ indicates increased; ↓, decreased; and ↑ ↓, negligible effect.

Soort Training?

Krachttraining als behandeling?

(Williams et al, Circulation, 2007)

Variable	Aerobic Exercise	Resistance Exercise
Body composition		
Bone mineral density	↑ ↑	↑ ↑
Percent body fat	↓ ↓	↓
Lean body mass	0	↑ ↑
Muscle strength	0 ↑	↑ ↑ ↑
Glucose metabolism		
Insulin response to glucose challenge	↓ ↓	↓ ↓
Basal insulin levels	↓	↓
Insulin sensitivity	↑ ↑	↑ ↑
Plasma lipids and lipoproteins		
HDL cholesterol	↑ 0	↑ 0
LDL cholesterol	↓ 0	↓ 0
Triglycerides	↓ ↓	↓ 0
Cardiovascular dynamics		
Resting heart rate	↓ ↓	0
Stroke volume, resting and maximal	↑ ↑	0
Cardiac output, rest	0	0
Cardiac output, maximal	↑ ↑	0
SBP at rest	↓ 0	0
DBP at rest	↓ 0	0
V _{o2} max	↑ ↑ ↑	↑ 0
Submaximal and maximal endurance time	↑ ↑ ↑	↑ ↑
Submaximal exercise rate-pressure product	↑ ↑ ↑	↑ ↑
Basal metabolic rate	↑ 0	↑
Health-related quality of life	↑ 0	↑ 0

Soort Training?

• Krachttraining als Behandeling bij MS: RCT's?

↓

Bij Type 2 diabetici

Krachttraining als behandeling bij Type 2 Diabetici?

Krachttraining additief bij Aerobe training (n=28)

(Cuff et al, Diabetes Care, 2003)

	Control group		Ae + RT		Ae only	
	Absolute	%	Absolute	%	Absolute	%
Weight (kg)	2.0 ± 1.2	2.1 ± 1.3	-2.9 ± 1.3*	3.2 ± 1.5	-1.2 ± 0.7*	1.5 ± 0.8
V _{o2} max (l/min)	-0.05 ± 0.06	-2.9 ± 3.4	0.17 ± 0.06	10.2 ± 3.7	0.22 ± 0.11	13.1 ± 6.5
Glycosylated hemoglobin (%)	-0.03 ± 0.20	-0.43 ± 0.29	-0.1 ± 0.22	-1.4 ± 3.2	-0.10 ± 0.11	1.99 ± 1.74
Glucose infusion rate (mg · kg ⁻¹ · min ⁻¹)	0.07 ± 0.28	3.1 ± 12.2	1.82 ± 0.52*	77.1 ± 22.0	0.55 ± 0.36	19.8 ± 12.9
CT						
Total abdominal AT (L4-L5) (cm ²)	17.1 ± 18.0	2.1 ± 2.2	-48.3 ± 18.4*	-6.7 ± 2.6	-17.0 ± 10.3	-2.8 ± 1.7
Subcutaneous (cm ²)	17.4 ± 9.0	3.2 ± 1.6	-22.0 ± 15.4	-4.7 ± 3.3	-8.2 ± 9.7	-2.0 ± 2.4
Visceral (cm ²)	-0.4 ± 12.0	-0.15 ± 4.6	-26.3 ± 7.4	-10.5 ± 2.9	-8.8 ± 5.4	-4.1 ± 2.5
High skeletal muscle						
Cross-sectional area (cm ²)	0.7 ± 1.6	0.3 ± 0.7	5.9 ± 2.0	2.8 ± 1.0	0.9 ± 2.1	0.4 ± 0.9
Low-density muscle (cm ²)	3.2 ± 1.0	6.3 ± 2.0	-4.1 ± 2.5*	-8.0 ± 4.9	-1.4 ± 1.3*	2.8 ± 2.6
Normal-density muscle (cm ²)	-3.5 ± 1.7	-2.0 ± 1.0	10.5 ± 2.0**	6.7 ± 1.3	2.3 ± 1.8*	1.3 ± 1.0

Data are means ± SEM. *Significant change compared with control group (P < 0.05). **Significant change compared with Ae only.

Krachttraining als behandeling bij Type 2 Diabetici?

A Randomized Controlled Trial of Resistance Exercise Training to Improve Glycemic Control in Older Adults With Type 2 Diabetes

Casteneda C, Layne JE, Munoz-Orians L, Gordon PL, Walsmith J, Foldvari M, Roubenoff R, Tucker KL, Nelson ME

Diabetes Care, 25(12):2335-41, 2002

Krachttraining als behandeling bij Type 2 Diabetici?

- RCT
- N=62 (66 jaar)
- 16 weken krachttraining
- 3x/week; 45 minuten

(Castaneda et al, Diabetes Care, 2002)

Dependent variable	IFT group	Control group	P*
Plasma glycosylated hemoglobin concentrations (%)			
Baseline	8.7 ± 0.3	8.4 ± 0.3	
Final	7.9 ± 0.2	8.3 ± 0.3	0.03
Mean glycohemoglobin (mean glycohemoglobin) †			
Baseline	402 ± 1.0	414 ± 2.2	
Final	393 ± 1.0	412 ± 2.7	0.04
Fasting plasma glucose concentrations (mmol/L)			
Baseline	8.8 ± 0.5	9.7 ± 0.7	
Final	7.9 ± 0.4	9.9 ± 0.7	0.14
Mean high-glucose concentrations (mmol/L)			
Baseline (median)	1.52	1.45	
Range	0.50-6.00	0.30-2.25	
Final (median)	1.31	1.56	0.02
Range	0.43-3.50	0.32-4.25	
Total cholesterol concentrations (mmol/L)			
Baseline	4.97 ± 0.18	4.70 ± 0.18	
Final	4.81 ± 0.16	4.70 ± 0.18	0.30
HDL cholesterol concentrations (mmol/L)			
Baseline	1.18 ± 0.09	1.23 ± 0.07	
Final	1.25 ± 0.06	1.24 ± 0.07	0.40
LDL cholesterol concentrations (mmol/L)			
Baseline	2.94 ± 0.18	2.72 ± 0.13	
Final	2.70 ± 0.13	3.05 ± 0.15	0.13
Systolic blood pressure (mmHg)			
Baseline	145.2 ± 3.6	142.7 ± 4.1	
Final	139.9 ± 3.3	150.4 ± 3.0	0.03
Diastolic blood pressure (mmHg)			
Baseline	99.2 ± 1.2	99.8 ± 1.4	
Final	92.1 ± 1.1	99.8 ± 1.4	0.02
Heart rate (beats/min)			
Baseline	71 ± 3	72 ± 2	
Final	72 ± 3	71 ± 3	0.74

Values are mean ± SE. *ANOVA with the absolute change on each dependent variable as the result. † = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. ‡ LDL values reflect the mean change from baseline—controlled data are available for 20 participants.

Krachttraining als behandeling bij Type 2 Diabetici?

(Castaneda et al, Diabetes Care, 2002)

Dependent variable	IFT group	Control group	P†
Body weight (kg)			
Baseline	78.1 ± 1.2	76.6 ± 1.1	
Final	78.1 ± 1.1	78.4 ± 2.0	0.98
Change in body mass (mean [kg])	0.0 ± 0.7	1.8 ± 1.0	0.04
Baseline	49.7 ± 0.9	48.9 ± 1.2	
Final	49.7 ± 0.9	49.1 ± 0.2	0.98
Change in lean mass (mean [kg])	0.0 ± 0.5	0.2 ± 0.6	0.04
Baseline	44.3 ± 0.7	44.0 ± 0.9	
Final	44.3 ± 0.7	44.0 ± 0.9	0.98
Change in fat mass (mean [kg])	0.0 ± 0.2	1.6 ± 0.5	0.04
Baseline	23.8 ± 0.8	22.8 ± 0.8	
Final	23.8 ± 0.8	23.9 ± 0.8	0.98
Change in bone mass (mean [kg])	0.0 ± 0.04	0.0 ± 0.04	0.97
Baseline	11.1 ± 0.06	10.9 ± 0.1	
Final	11.1 ± 0.06	10.9 ± 0.1	0.97
Change in fat-free mass (mean [kg])	0.0 ± 0.04	0.2 ± 0.4	0.04
Baseline	30.9 ± 0.3	30.5 ± 0.4	
Final	30.9 ± 0.3	30.5 ± 0.4	0.04
Change in muscle mass (mean [kg])	0.0 ± 0.04	0.0 ± 0.04	0.98
Baseline	18.8 ± 0.1	18.2 ± 0.1	
Final	18.8 ± 0.1	18.0 ± 0.1	0.01
Change in visceral fat (mean [kg])	0.0 ± 0.04	0.4 ± 0.1	0.01
Baseline	30.9 ± 0.4	30.4 ± 0.5	
Final	30.9 ± 0.4	30.4 ± 0.5	0.01
Change in total fat mass (mean [kg])	0.0 ± 0.04	0.4 ± 0.1	0.01
Baseline	48.7 ± 2.3	48.0 ± 2.8	
Final	48.7 ± 2.3	48.0 ± 2.8	0.01
Change in physical activity score	84 ± 4	10 ± 2	0.001
Baseline	39.1 ± 0.9	12 ± 0.9	
Final	39.1 ± 0.9	12 ± 0.9	0.001
Change in physical activity score	17 ± 0.8	12 ± 0.8	0.001
Baseline	17 ± 0.8	12 ± 0.8	0.001
Final	17 ± 0.8	12 ± 0.8	0.001

Values are mean ± SE. † = ANOVA with the absolute change on each dependent variable as the result. ‡ = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. § = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. ¶ = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. †† = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. ††† = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. †††† = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use. ††††† = result adjusted for baseline use, years of diabetes, sex, and the change in physical activity and in diabetes medication use.

MS & Lichamelijke Activiteit

- Preventie:
 - Relatie tussen fysieke (in)activiteit en metabool syndroom
- Behandeling
 - Effecten
 - Soort training?
 - **Conclusie**
- Aanbevelingen

Conclusie

- MS = incidentie stijgt met toenemende leeftijd
 - Kosten-baten analyse
 - Grotere kans op aanwezigheid CAD

Krachttraining = bruikbaar als additief bij Uithoudingstraining

Uithoudingstraining = in combinatie met Dieet

Aanbevelingen Type 2

Diagnosis and Management of the Metabolic Syndrome
An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement
Executive Summary

Scott M. Grundy, MD, PhD, Chair; James I. Cleeman, MD, Co-Chair; Stephen R. Daniels, MD, PhD; Karen A. Donato, MS, RD; Robert H. Eckel, MD; Barry A. Franklin, PhD; David J. Gordon, MD, PhD, MPH; Ronald M. Krauss, MD; Peter J. Savage, MD; Sidney C. Smith, Jr, MD; John A. Spertus, MD; Fernando Costa, MD

Circulation, 112:e285-e290, 2005

Aanbevelingen

Therapeutic Target and Goals of Therapy	Therapeutic Recommendations
Abdominal obesity Goal: Reduce body weight by 7%–10% during first year of therapy. Continue weight loss thereafter to extent possible with goal to ultimately achieve desirable weight (BMI <25 kg/m ²)	Consistently encourage weight maintenance/reduction through appropriate balance of physical activity, caloric intake, and formal behavioral programs when indicated to maintain/achieve waist circumference of <40 inches in men and <35 inches in women. Aim initially at slow reduction of ~7%–10% from baseline weight. Even small amounts of weight loss are associated with significant health benefits.
Physical inactivity Goal: Regular moderate-intensity physical activity; at least 30 min of continuous/intersittent (preferably 60 min) 5 d/week, but preferably daily	In patients with established CVD, assess risk with detailed physical activity history and/or exercise test, to guide prescription. Encourage 30–40 min moderate-intensity aerobic activity (eg, brisk walking), preferably daily, supplemented by increase in daily lifestyle activities (eg, pedometer step tracking, walking breaks at work, gardening, household work). Higher exercise times achieved by accumulating exercise throughout day. Encourage resistance training 2 d/week. Advise medically supervised programs for high-risk patients (eg, recent acute coronary syndrome or revascularization, CHF).
Atherogenic diet Goal: Reduced intakes of saturated fat, trans fat, cholesterol	Recommendations: Saturated fat <7% of total calories; reduce trans fat; dietary cholesterol <200 mg/d; total fat 25%–35% of total calories. Most dietary fat should be unsaturated, simple sugars should be limited.

BMI indicates body mass index; CVD, cardiovascular disease; and CHF, congestive heart failure.

(Grundey et al. Circulation, 2005)

