THE METABOLIC SYNDROME: A THREAT FOR BOTH FLIGHT PERSONNEL AND PASSENGERS

Felice STROLLO

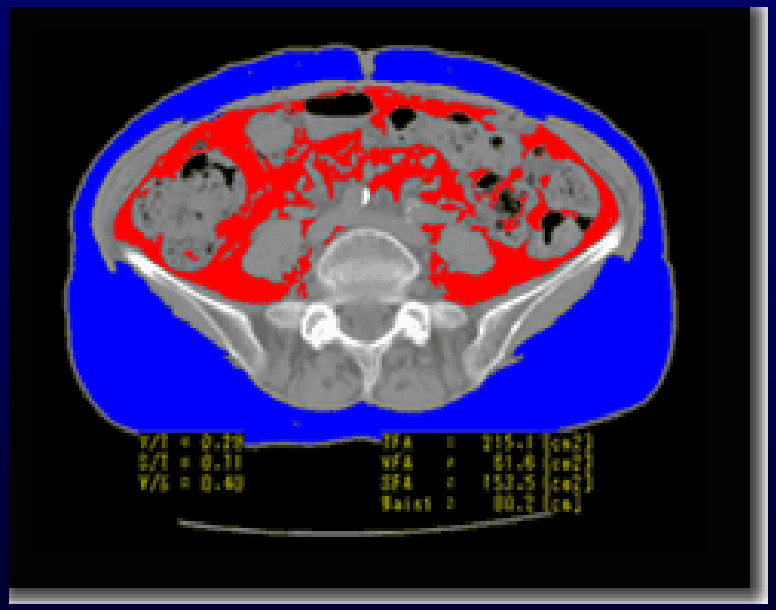
ESAM Secretary General
Diabetes Unit – San Raffaele Institute – Rome, Italy

Abdominal obesity and metabolic syndrome

Jean-Pierre Després & Isabelle Lemieux

Nature 444: 881-87, 2006.

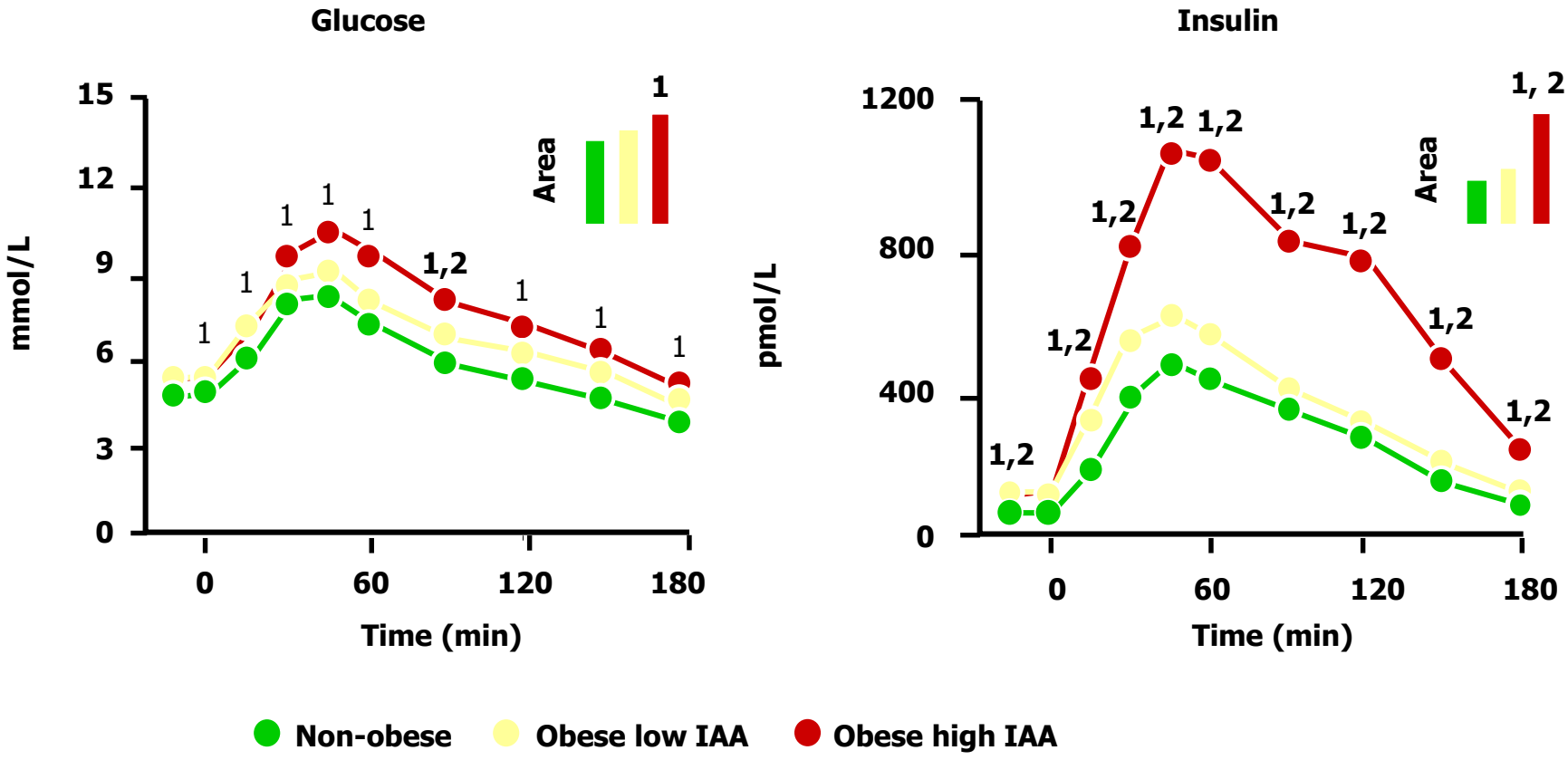
Abdominal obesity,
the most prevalent manifestation of the MS,
is a marker of 'dysfunctional adipose tissue',
and is of central importance in clinical diagnosis.



Visceral Adipose Tissue (VAT)

Subcutaneous A. T. (SAT)

Intra-abdominal adiposity and glucose metabolism

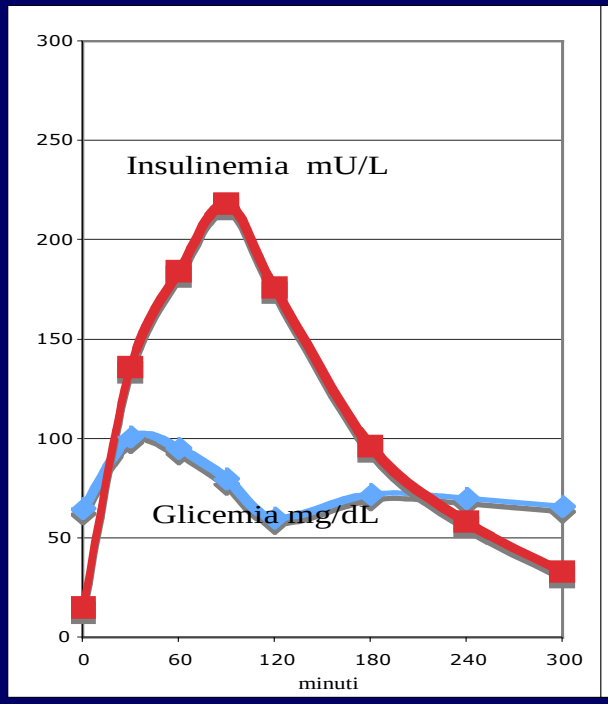


IAA: intra-abdominal adiposity
Significantly different from [1]non-obese, [2]obese with low intra-abdominal adiposity levels

Pouliot et al 1992

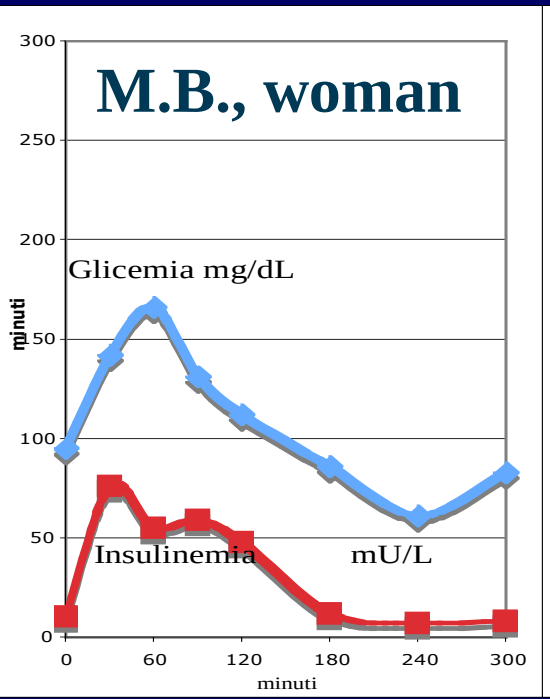
February 2003

BMI 33.4, W 102



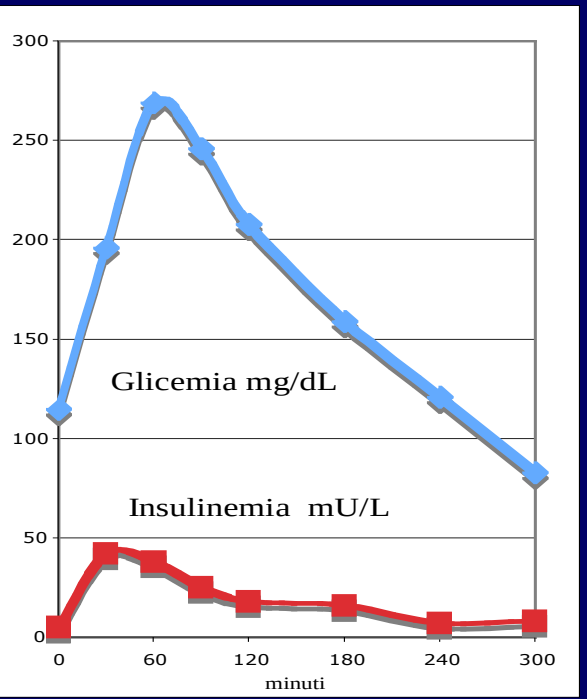
May 2004

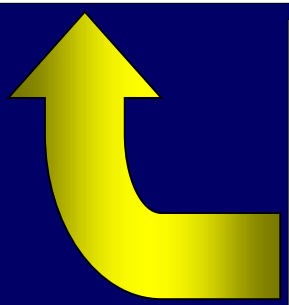
BMI 32,9, W 108

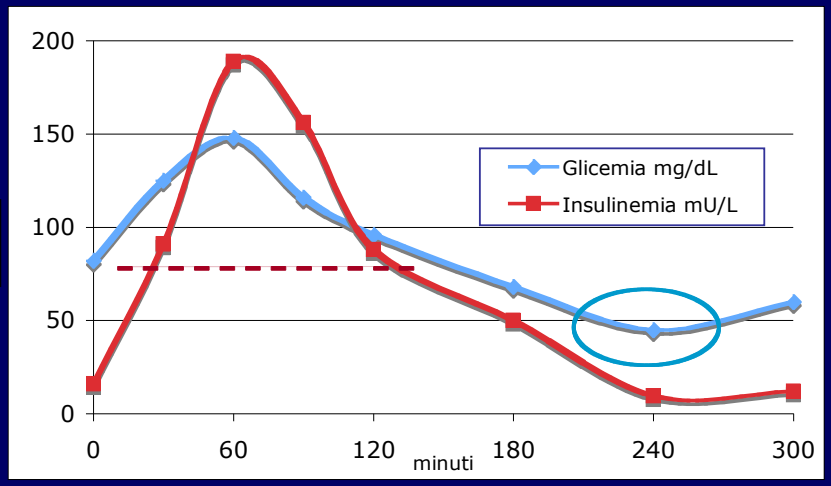


Spetember 2005

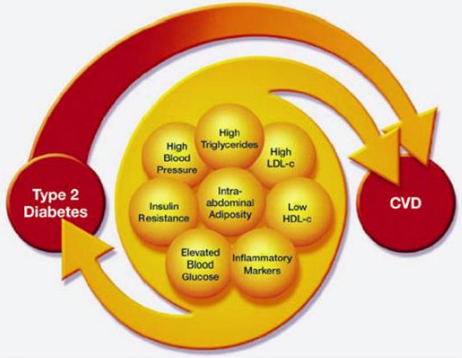
BMI 32,6, W112







CRITERIA	ATP III (2006): at least 3 criteria
OBESITY	Waist circumference men ≥ 102 cm; women ≥ 88 cm
DYSLIPIDEMIA	a) Triglicerides ≥ 150 mg/dl and/or therapy b) HDL-C men <40 mg/dl; women <50 mg/dl and/or therapy
HYPERTENSION	≥ 130/85 mmHg. and/or therapy
GLYCEMIA	≥ 100 mg/dl. and/or therapy
INSULIN - RESISTANCE	*No marker*



*A cluster of **INSULIN-RESISTANCE-RELATED CHANGES** in **METABOLISM** (lipids + glucose) and **VESSELS** (hypertension + trombophylia) leading to **INCREASED CV RISK***

Dyslipidemia
Total-C ↑
LDL-C ↑
Triglycerides ↑
Apo-B ↑
HDL-C ↓

Hypertension
Left ventricular hypertrophy
Congestive heart failure

Insulin resistance
Glucose intolerance
Hyperglycemia
Type 2 diabetes

Endothelial dysfunction

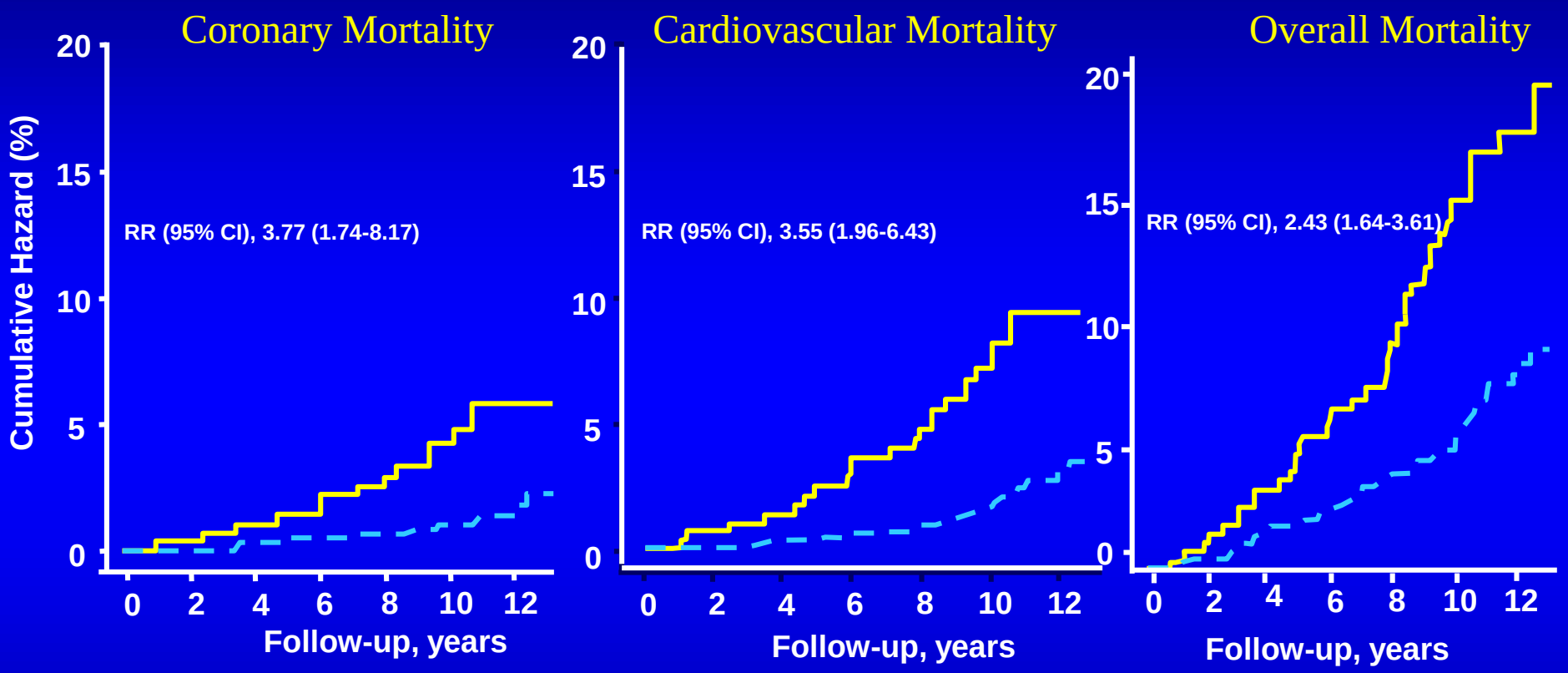
Visceral Obesity

Prothrombosis
Fibrinogen ↑
PAI-1 ↑

Inflammatory Response ↑

Renal Hyperfiltration
Albuminuria

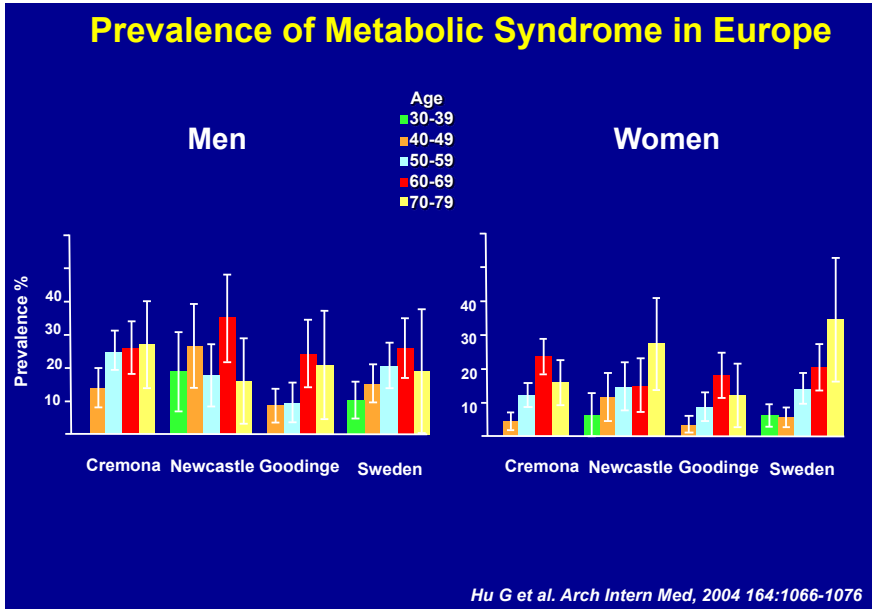
Metabolic Syndrome: prognosis



Lakka H-M, et al. *JAMA*. 2002;288:2709-2716.

PASSENGER HEALTH: MOSTLY IGNORED

- when combined with
  - smoking and
  - aging
- the MS is a risk factor for well known threats during long-haul flights:
  - venous thrombo-embolism,
  - arterial thrombosis.



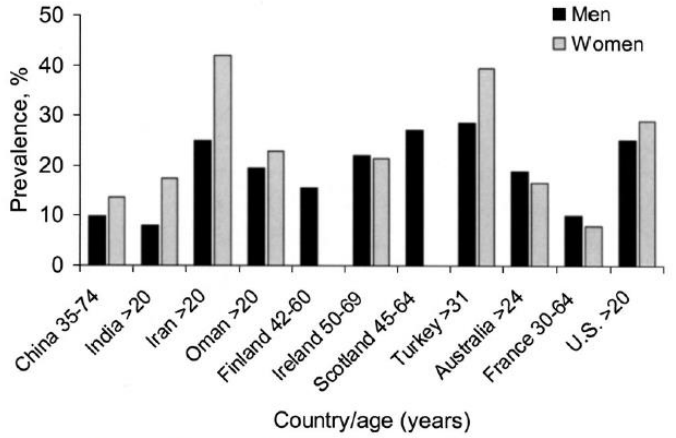
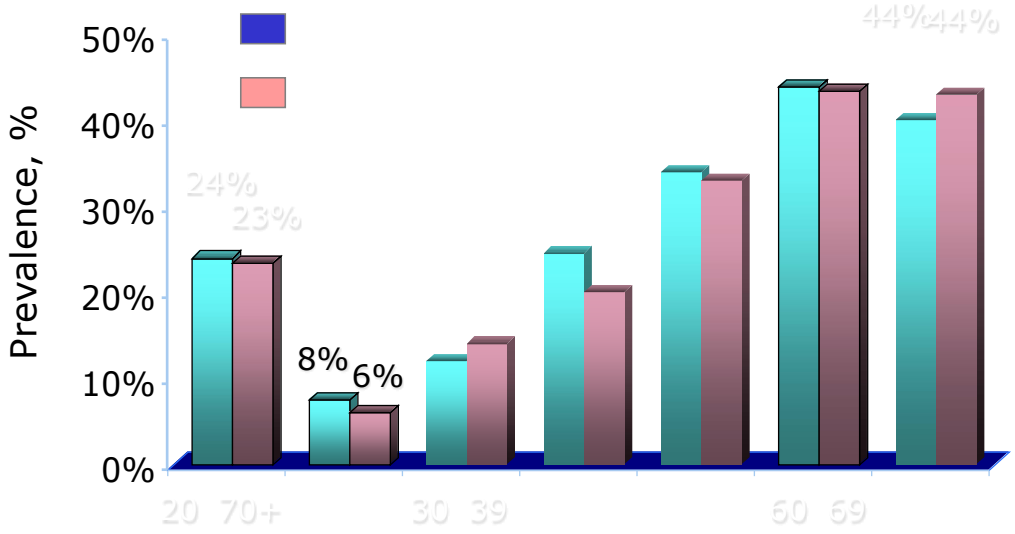


Figure 1. Prevalence of the metabolic syndrome in various countries according to the ATP III definition. (Adapted from Gu D et al. Lancet 2005;365:1398–1405; Eckel et al. Lancet. 2005;365: 1415–28; and Ford E et al. Diabetes Care. 2004;27:2444–9.)

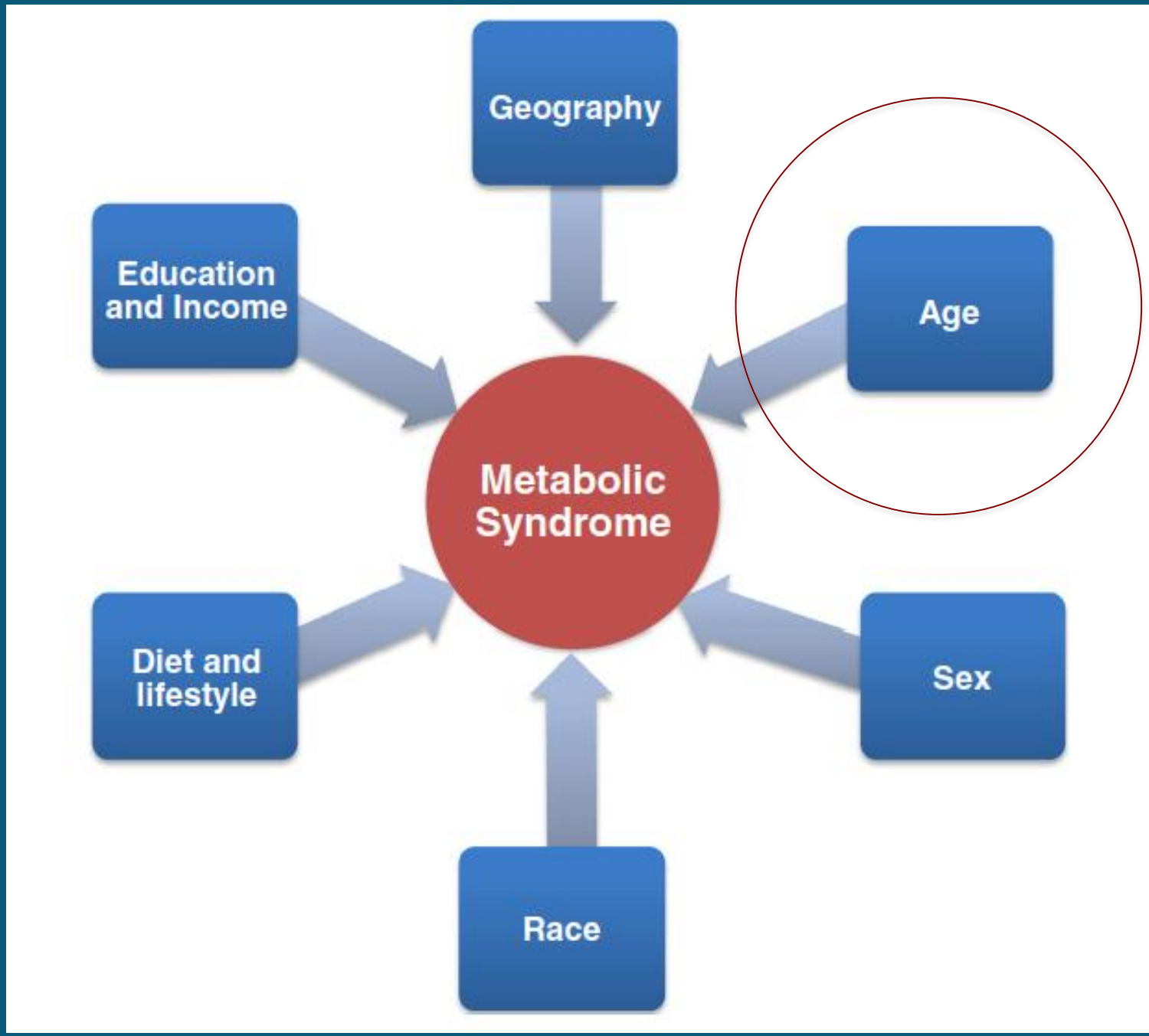
Prevalence of the NCEP Metabolic Syndrome: *NHANES III by Age*



Mean = 25-30%

>60 yrs ≅ 40%

Ford ES et al. JAMA 2002;287:356-359.


Geography
Education and Income
Age
Metabolic Syndrome
Diet and lifestyle
Sex
Race

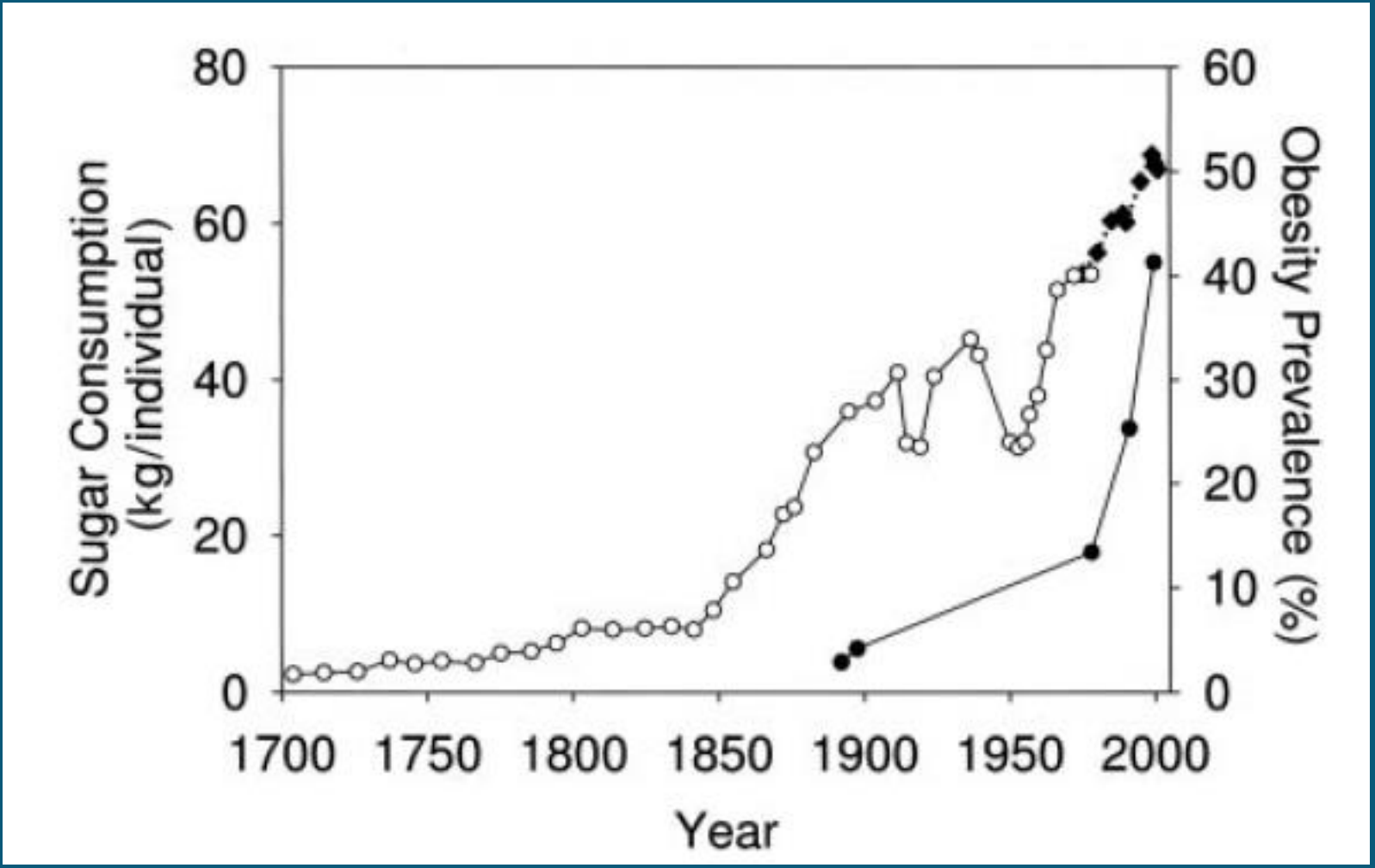
WHAT ABOUT THE MILITARY AIRCREW?

- cardiovascular disease and diabetes mellitus negatively influence quality of life
- they are also disabling for aging military aircrew;
- among Royal Jordanian Air Force pilots its prevalence was shown to be the same as in the general population;
- this raises medical concern, since military pilots are generally regarded as healthy and fit, somehow “forever young” after their first evaluation.

Khazale NS, Haddad F . Aviat Space Environ Med. 2007;78(10):968-72

Potential role of sugar (fructose) in the epidemic of hypertension, obesity and the metabolic syndrome, diabetes, kidney disease, and cardiovascular disease[1–3]

Richard J Johnson, Mark S Segal, Yuri Sautin, Takahiko Nakagawa, Daniel I Feig, Duk-Hee Kang, Michael S Gersch, Steven Benner, and Laura G Sánchez-Lozada

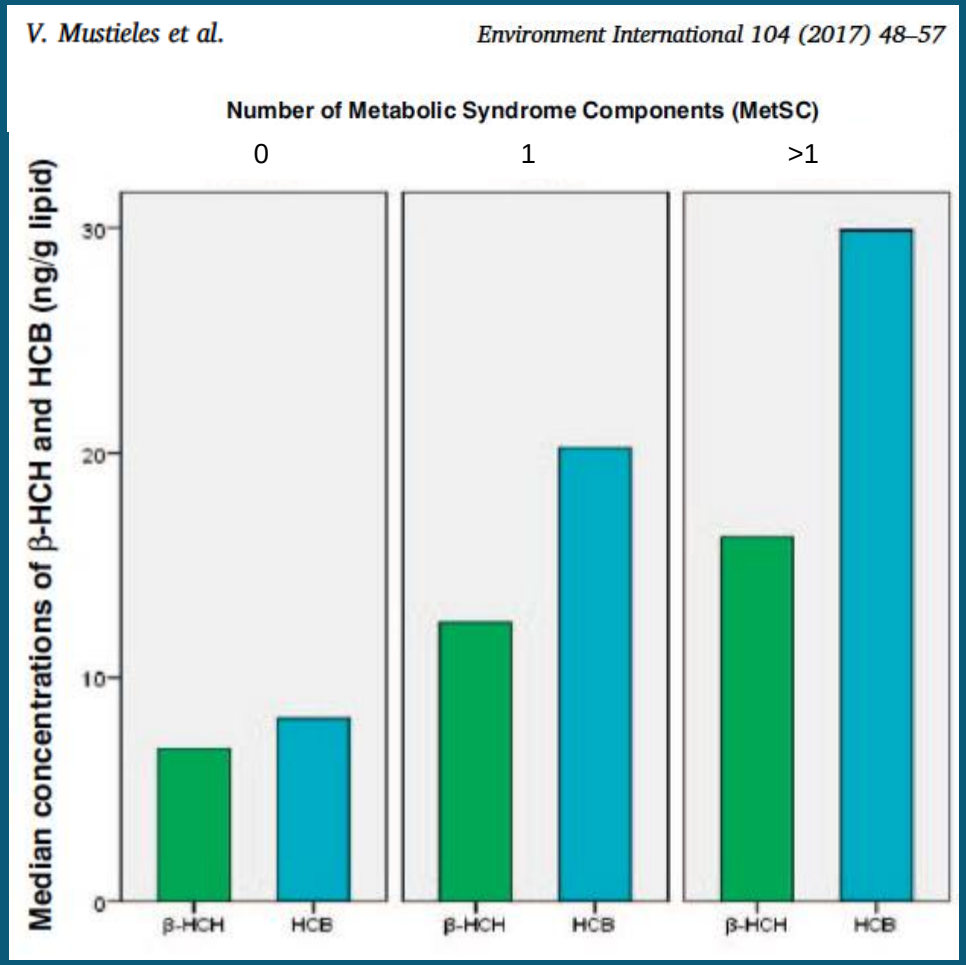


Am J Clin Nutr 2007;86:899–906.

- Residues of 8 Persistent Organic Pollutants (POPs) in adipose tissue samples from 387 people in Granada province (Spain, 2003 - 2004).
- β-HCH and HCB = independently associated with increased metabolic risk (ORs =1.17, p<0.05) also after a 10-year follow-up (OR =1.25, p<0.05).

β-HCH = β-hexachlorocyclohexane (cotton plant pesticide)

HCB = hexachlorobenzene (wheat fungicide + byproduct of industrial chemicals)



These POPs might be partly responsible for the morbidity risk traditionally attributed to age and obesity.

Influence of Age on the Relationship between Alcohol Consumption and Metabolic Syndrome

Gerontology 2012;58:24–31

Ichiro Wakabayashi

Table 3. Comparison of prevalence of each risk factor for atherosclerosis or metabolic syndrome (MetS) among nondrinker, light drinker, heavy drinker and very heavy drinker subgroups of the younger (Y) and older (O) subject groups

Variable (Y: 35-45 yrs; n = 1390; O: ≥ 65 yrs; n = 1390)	Overall	Drinker group: nondrinker	light	heavy	very heavy
Large waist circumference, %	Y: 36.3 O: 44.4††	Y: 40.0 O: 44.4	Y: 31.2* O: 43.7	Y: 34.8 O: 45.0	Y: 36.3 O: 43.6
High blood pressure, %	Y: 45.5 O: 76.8††	Y: 39.8 O: 69.3	Y: 43.7 O: 75.8	Y: 47.6* O: 80.0**	Y: 55.4** O: 88.2**
Low HDL cholesterol, %	Y: 8.6 O: 13.2††	Y: 15.6 O: 22.8	Y: 5.6** O: 12.1**	Y: 4.7** O: 7.4**	Y: 4.4** O: 5.9**
High triglycerides, %	Y: 32.7 O: 26.0††	Y: 32.8 O: 28.8	Y: 24.7* O: 20.9*	Y: 32.5 O: 24.5	Y: 41.7* O: 28.4
High HbA_{1c}, %	Y: 3.8 O: 14.5††	Y: 6.8 O: 15.6	Y: 0.5** O: 16.7	Y: 2.0** O: 14.9	Y: 4.4 O: 8.3*
MetS by IDF, %	Y: 13.7 O: 23.3††	Y: 16.0 O: 25.5	Y: 9.8* O: 22.8	Y: 11.5* O: 22.3	Y: 17.6 O: 21.1
MetS by NCEP-ATP III, %	Y: 13.8 O: 24.7††	Y: 16.2 O: 27.2	Y: 9.8* O: 23.4	Y: 11.7* O: 23.7	Y: 17.6 O: 23.0

The prevalence of each risk factor for atherosclerosis or metabolic syndrome is shown. Light drinkers: <22 g ethanol/day; heavy drinkers: ≥22 and <44 g ethanol/day; very heavy drinkers: ≥44 g ethanol/day. Marks denote significant differences from the nondrinker subgroup (* $p < 0.05$; ** $p < 0.01$) and the younger group (†† $p < 0.01$).

ASSOCIATED PATHOLOGIC CONDITIONS:

- steato-hepatitis
- male hypogonadism
- osteopenia
- depression

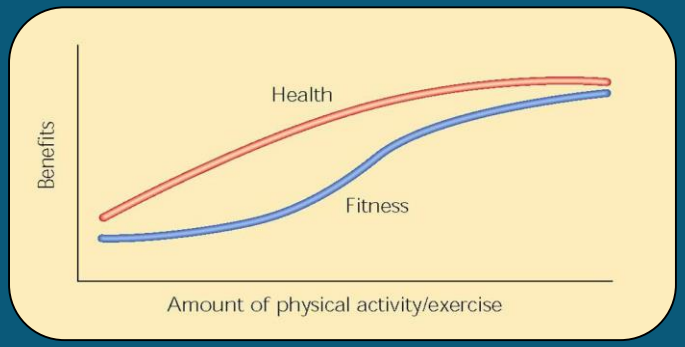


TABLE 3. **ABCDE Approach for Treating the Metabolic Syndrome**[a,b]

A	Assessment	Make metabolic syndrome diagnosis, *ICD-9* code 277.7 Calculate Framingham risk score
	Aspirin	All patients with >6% 10-y Framingham risk
B	Blood pressure control	Goal blood pressure is <130/80 mm Hg if intermediate risk (≥6% 10-y risk) First-line therapy: ACEI or ARB β-Blockers, thiazide diuretics may increase risk of diabetes
C	Cholesterol management	
	First target: LDL-C	Statins to achieve LDL-C <100 mg/dL in high-risk, <130 mg/dL in intermediate-risk (≥6% 10-y risk) patients per the NCEP ATP III
	Second target: non-HDL-C	Statin intensification Fenofibrate to achieve target non–HDL-C <130 mg/dL in high-risk, <160 mg/dL in intermediate-risk patients per NCEP ATP III Consider omega-3 fatty acids
	Third target: HDL-C	Long-acting niacin, although insufficient evidence for wide use of niacin at this time due to concern for increased glucose intolerance
D	Diabetes prevention	Intensive lifestyle modification for all patients; pharmacotherapy is second line Metformin Consider pioglitazone
	Diet	Weight loss Mediterranean diet: increase omega-3 fatty acids, fruits, vegetables, fiber, nuts Low glycemic load diet
E	Exercise	Daily vigorous activity Recommend use of pedometer with goal >10,000 steps/d

Blaha MJ et al. ***Mayo Clin Proc.* 2008;83(8):932-943**

METABOLIC SYNDROME AND RELATED DISORDERS
Volume 8, Number 4, 2010

Pp. 317–322
DOI: 10.1089/met.2009.0090

Walking in Old Age and Development of Metabolic Syndrome: The Health, Aging, and Body Composition Study

Matthew J. Peterson, Ph.D.,[1–3] Miriam C. Morey, Ph.D.,[1,3] Carol Giuliani, Ph.D.,[2] Carl F. Pieper, Dr.P.H.,[1,3] Kelly R. Evenson, Ph.D.,[4] Vicki Mercer, Ph.D.,[2] Marjolein Visser, Ph.D.,[5] Jennifer S. Brach, Ph.D., P.T., G.C.S.,[6] Stephen B. Kritchevsky, Ph.D.,[7] Bret H. Goodpaster, Ph.D.,[8] Susan Rubin, M.P.H.,[9] Suzanne Satterfield, M.D., Dr.P.H.,[10] and Eleanor M. Simonsick, Ph.D.,[11,12] for the Health ABC Study

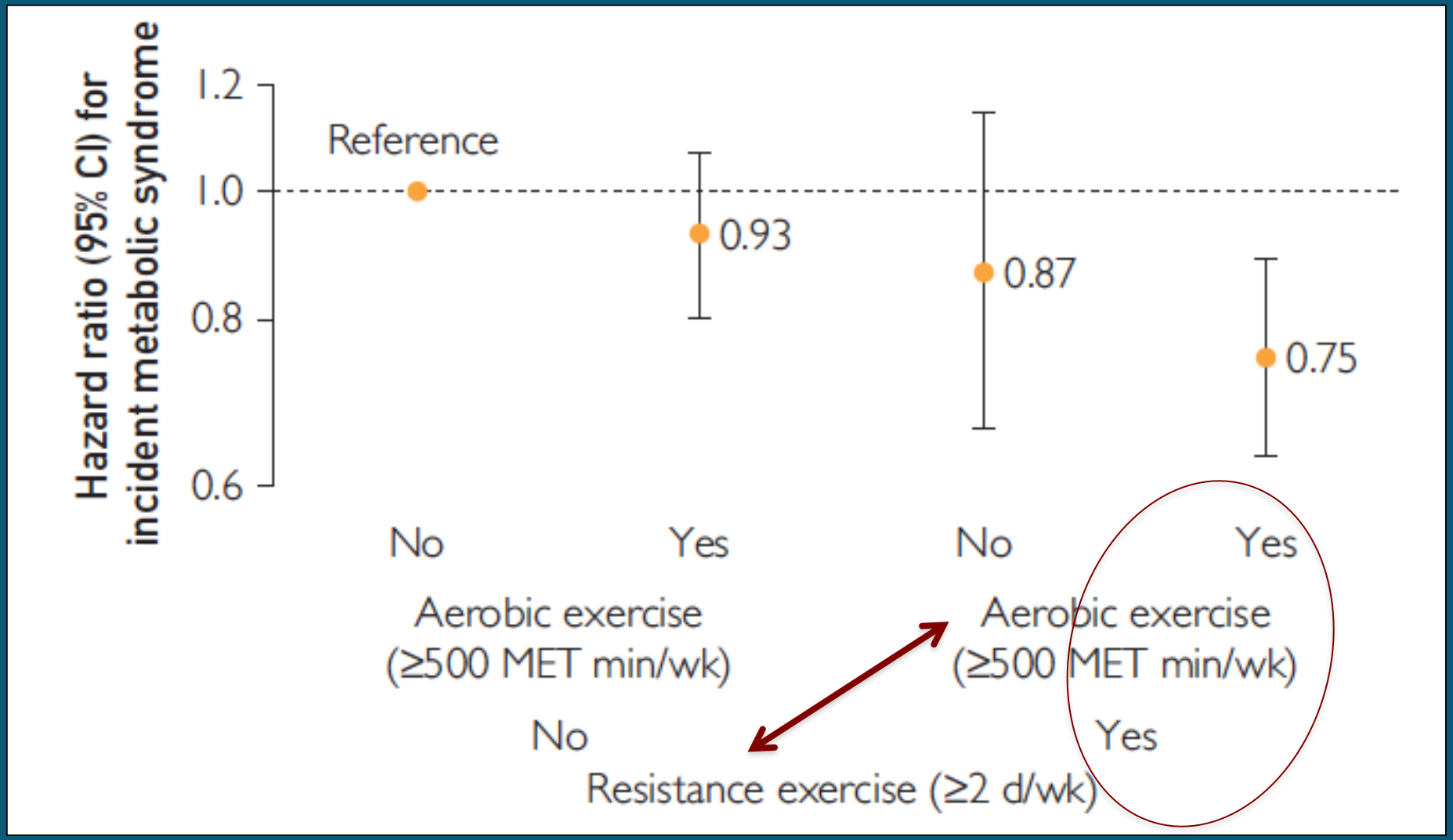
N = 1863 sigjects
Age = 70–79 years
Follow-up = 5 years
Exercise self-report

- sustained low (<150 min/wk)
- decreased (from >150 to <150 min/wk)
- increased (from <150 to >150 min/wk)
- sustained high (>150 min/wk)

	Metabolic syndrome[a]		*Number of metabolic syndrome risk factors*[b]			
	Model 1[c]	*Model 2*[d]	*Model 1*[d]		*Model 2*[e]	
Walking group	*OR (95% CI)*	*OR (95% CI)*	*β*	*p*	*β*	*p*
Sustained low	1.00	1.00	0		0	
Decreased	0.95 (0.71–1.26)	0.97 (0.73–1.30)	−0.06	0.37	−0.07	0.29
Increased	1.05 (0.69–1.61)	1.04 (0.67–1.60)	−0.08	0.42	0.02	0.84
Sustained high	0.59 (0.38–0.89)	0.61 (0.40–0.93)	−0.23	0.007	−0.16	0.04

[d]Adjusted for year 1 body weight, race, education, number of diagnoses, heart disease, and year 1 min/week in high-intensity exercise.

[e]Adjusted for year 1 body weight, race, education, number of diagnoses, heart disease, baseline min/week in high-intensity exercise, and number of metabolic syndrome factors present at year 1.



Bakker EA et al. Mayo Clin Proc. 2017; http://dx.doi.org/10.1016/j.mayocp.2017.02.018

2008 US PHYSICAL ACTIVITY GUIDELINES

RESISTANCE EXERCISE
≥2 d/wk moderate-high intensity, all major muscle groups

AEROBIC EXERCISE
≥500 metabolic equivalent min/wk (≥8.5 MET/h/wk)

TABLE 2. Hazard Ratios for Metabolic Syndrome in 7418 Study Participants Stratified by Weekly Frequency and Minutes of Resistance Exercise[a]

Variable	No. (%) of participants	No. of MetS cases	Adjusted hazard ratio (95% CI) Model 1[b]	Model 2[c]	Model 3[d]
Weekly minutes of resistance exercise					
0	4633 (62)	816	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
1-59	670 (9)	80	0.62 (0.49-0.78)	0.69 (0.55-0.86)	0.71 (0.56-0.89)
Recommended resistance exercise					
No (<2 d/wk)	4839 (65)	838	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Yes (≥2 d/wk)	2579 (35)	309	0.71 (0.62-0.80)	0.81 (0.71-0.92)	0.83 (0.73-0.96)

[a]MetS = metabolic syndrome.
[b]Adjusted for age, sex, and examination year.
[c]Adjusted for model 1 plus body mass index, current smoking, heavy alcohol drinking, abnormal electrocardiographic findings, and parental history of cardiovascular disease, hypertension, and diabetes.
[d]Adjusted for model 2 plus aerobic exercise (inactive, insufficient, medium, and high).

Bakker EA et al. Mayo Clin Proc. 2017; http://dx.doi.org/10.1016/j.mayocp.2017.02.018

POSSIBLE COUNTERMEASURES FOR FLIGHT PERSONNEL

Both pilots and flight attendants should be provided with:

- continuous structured nutritional education and
- regular exercise counseling and monitoring

POSSIBLE COUNTERMEASURES FOR PASSENGERS

- Need to prevent life-threatening CV events during the travel, implying
  - huge emotionally relevant consequences
  - related socio-economic burden
- for:
  - flight companies
  - the society itself.

- Strong actions should be urgently taken to
  - limit weight gain and
  - identify those at risk for or affected by the MetS.

HOW?

Frequent travellers might be the object of extensive / hammering institutional information campaigns through

- the media
- travel agencies and
- airport access points.