Deutsches Institut für Ernährungsforschung Potsdam-Rehbrücke
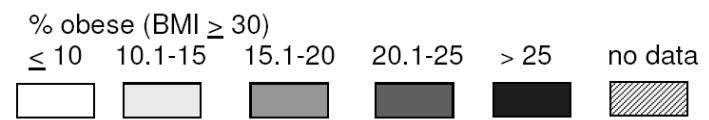
General and Abdominal Adiposity and Risk of Death in Europe

Tobias Pischon

Department of Epidemiology

German Institute of Human Nutrition Potsdam-Rehbruecke

Leibniz Gemeinschaft

Prevalence of Obesity in Europe (Men)

% obese (BMI ≥ 30)

≤ 10	10.1-15	15.1-20	20.1-25	> 25	no data

Based on reports with direct measurement of weight and height (with the exception of France)

Age range and time of data collection may vary across countries

Berghoefer, et al. BMC Public Health 2008

Classification of Overweight and Obesity by BMI

$$BMI = \frac{Body\ weight\ (kg)}{Height^2\ (m^2)}$$

Classification	BMI (kg/m^2)
Underweight	< 18.5
Normal weight	18.5 – 24.9
Overweight	25.0 – 29.9
Obesity Grade I	30.0 – 34.9
Obesity Grade II	35.0 – 39.9
Obesity Grade III	$\geq$ 40.0

Risk of Chronic Disease (Men)

	Normal weight	Overweight	Obesity Grade I	Obesity Grade II/III
Type 2 diabetes	1 (reference)	3.5	11.2	23.4
Gallstones	1 (reference)	1.4	2.3	2.9
Hypertension	1 (reference)	1.7	2.7	3.0
High cholesterol levels	1 (reference)	1.3	1.2	1.3
Heart disease	1 (reference)	1.5	2.0	2.2
Stroke	1 (reference)	1.2	2.0	2.3

Field et al., Arch Intern Med 2001

Relative and Attributable Risk of Cancer
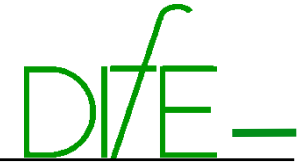
Tumor	Relative risk		Attributable Risk (EU)
	Overweight	Obesity	
Colorectal cancer (men)	1.5	2.0	28 %
Colorectal cancer (women)	1.2	1.5	14 %
Postmenopausal breast cancer	1.3	1.5	17 %
Endometrial cancer	2.0	3.5	45 %
Renal cell cancer	1.5	2.5	31 %
Oesophageal cancer (adenocarcinoma)	2.0	3.0	43 %
Pancreatic cancer	1.3	1.7	19 %

Calle & Kaaks, Nat Rev Cancer 2004

Causes of Death in Germany
(% of All Deaths in 2004; Total: 818 271)

DIfE

Diseases of the
Digestive System
5.2

Other Causes
13.7

Injury, Poisoning
(External Causes)
4.1

Respiratory
Diseases
6.4

Circulatory
Diseases
45.0

Malignant
Neoplasms
25.7
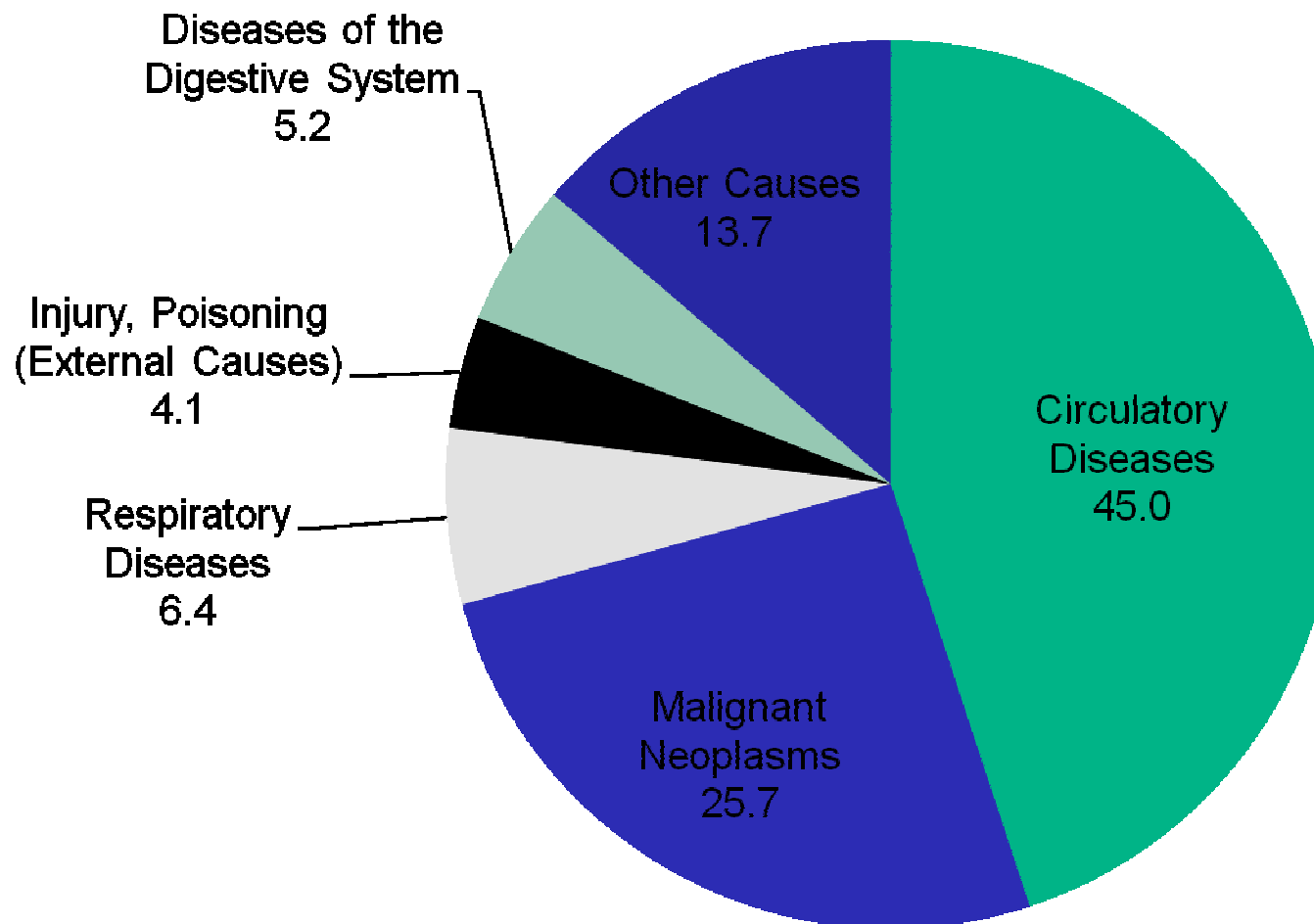
Survival Curves According to BMI Groups in Patients With Heart Failure – The Obesity Paradox
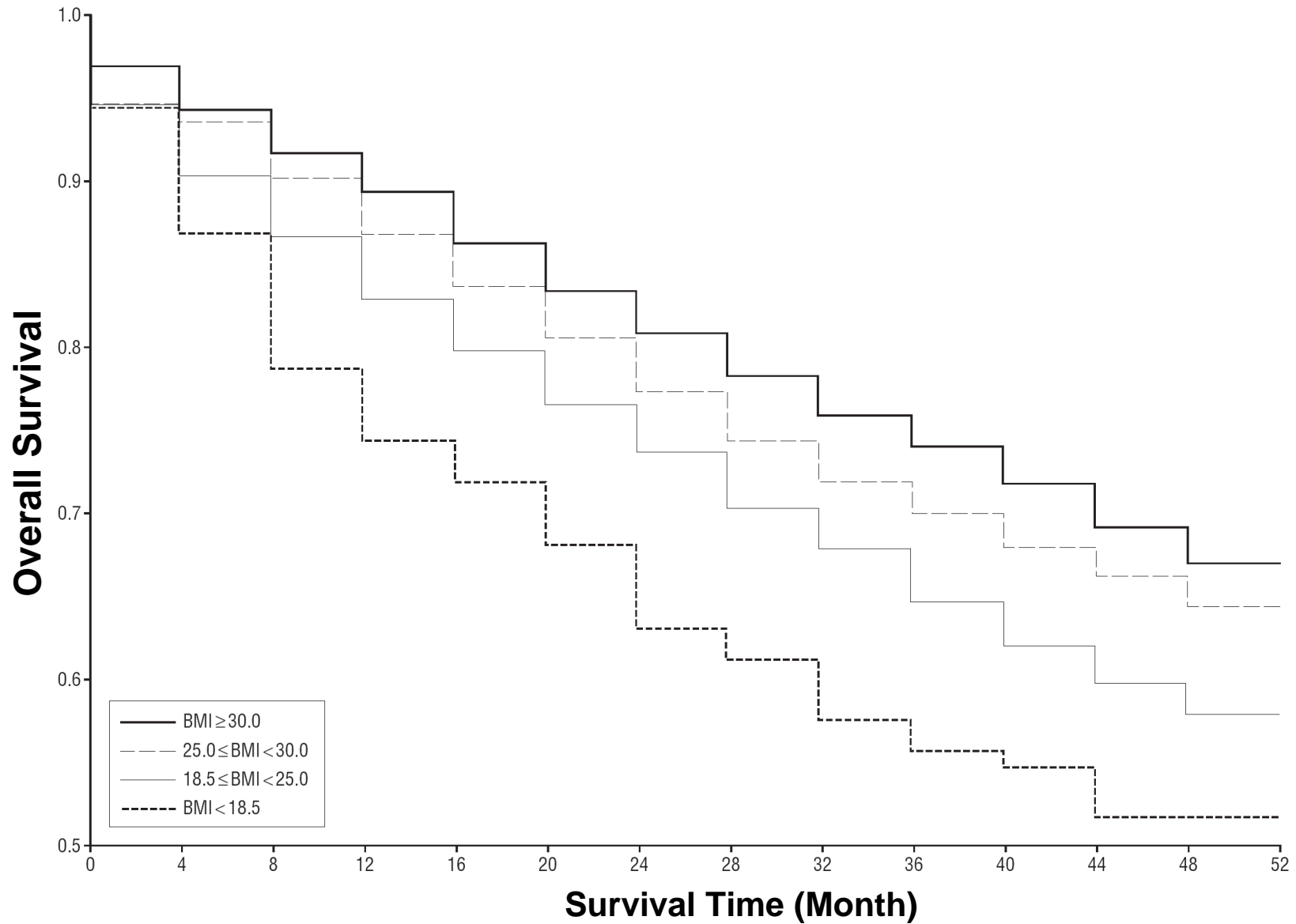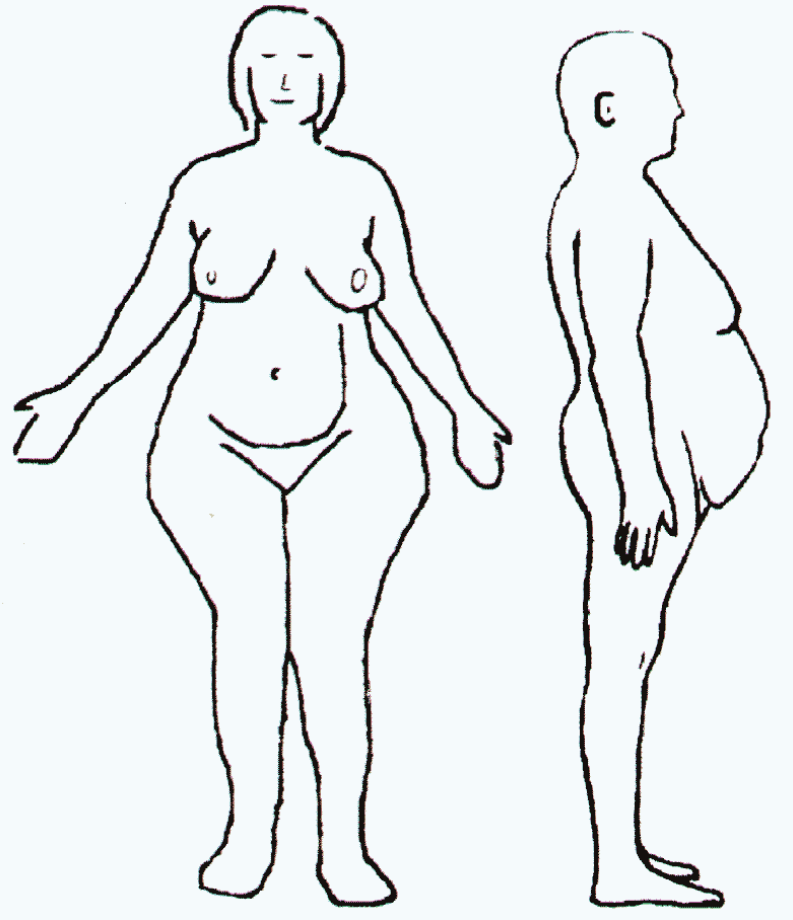

Curtis et al., Arch Intern Med 2005

Body Fat Distribution Patterns
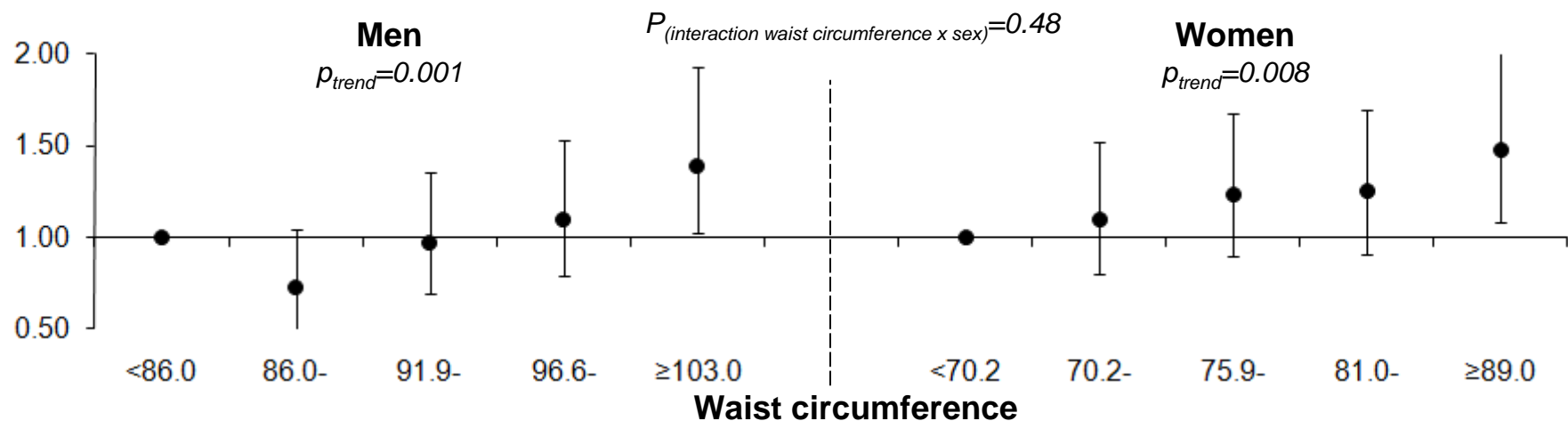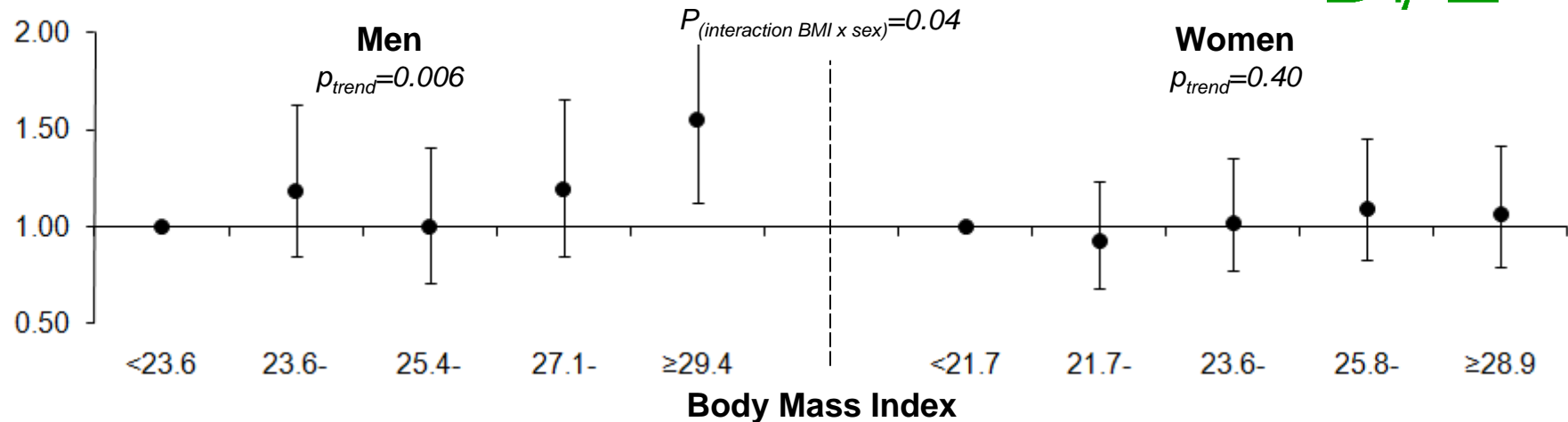
**Gluteal-femoral
Fat Distribution**

- More prevalent in
women

- Lower risk of metabolic
abnormalities

**Abdominal
Fat Distribution**

- More prevalent in men

- Higher risk of metabolic
abnormalities

Relative Risk of Colon Cancer According to BMI or Waist Circumference (EPIC-Study)

N=368,277; 6.1 years of follow-up; 984 incident cases of colon cancer
Adjusted for age, study center, smoking status, education, alcohol consumption, physical activity, fiber intake, and consumption of red and processed meat, fish and shellfisch, and fruits and vegetables

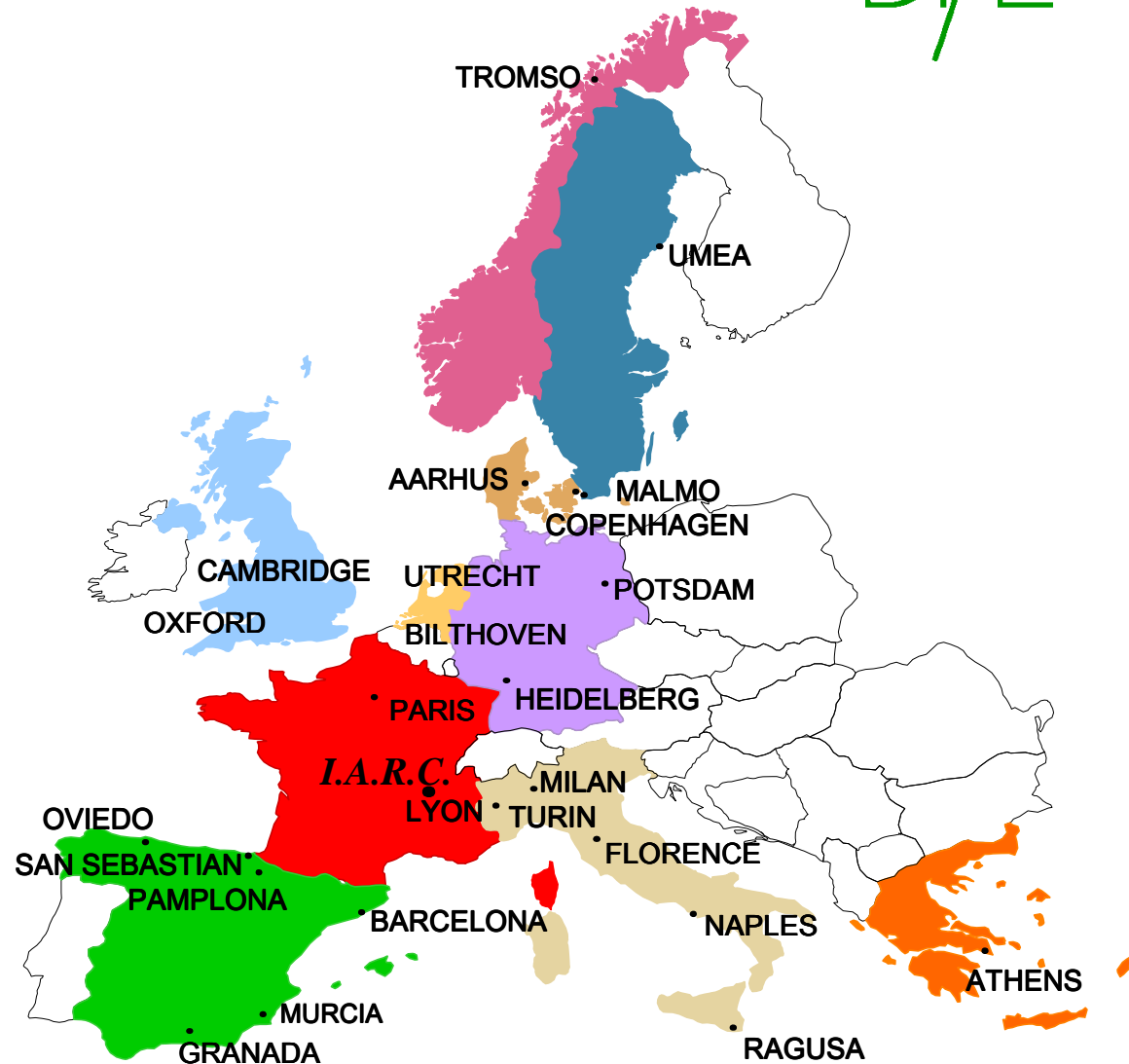*Pischon et al., J Natl Cancer Inst 2006*

European Prospective Investigation into Cancer and Nutrition (EPIC)

- 23 study centers in 10 European countries
- Recruitment 1992-2000
- 519,978 participants
- Age 25-70 years

Exclusions:

- Weight or height not measured
- No information on physical activity
- No questionnaire completed
- Ratio of energy intake to energy expenditure above 99th or below 1st percentile
- Chronic diseases at baseline (cancer, heart disease, stroke)
- Remaining study population: **359,387 participants**

TROMSO

UMEA

AARHUS

MALMO

COPENHAGEN

CAMBRIDGE

UTRECHT

POTSDAM

OXFORD

BILTHOVEN

HEIDELBERG

PARIS

I.A.R.C.

MILAN

LYON

TURIN

OVIEDO

FLORENCE

SAN SEBASTIAN

PAMPLONA

BARCELONA

NAPLES

MURCIA

ATHENS

GRANADA

RAGUSA

Results: Study Participants

| Country	Number of participants		Mean age (years)		Mean follow-up time (years)		Number of deaths	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
France	0	19.589	-	53	-	12,9	0	348
Italy	13.648	30.150	50	51	9,1	9,2	370	516
Spain	14.787	24.455	51	48	10,9	10,8	675	430
UK	21.365	50.828	52	48	9,2	9,4	1.543	1.673
Netherlands	9.511	25.919	43	51	10,6	9,8	326	820
Greece	10.025	14.722	52	53	7,0	7,3	686	426
Germany	20.453	27.366	52	49	8,3	8,3	868	425
Sweden	9.521	13.798	59	57	11,4	11,4	1.196	845
Denmark	25.042	28.208	57	57	9,9	10,1	2.141	1.435
Total	**124.352**	**235.035**	**53**	**51**	**9,5**	**9,8**	**7.805**	**6.918**

Association of BMI With Risk of Death in EPIC
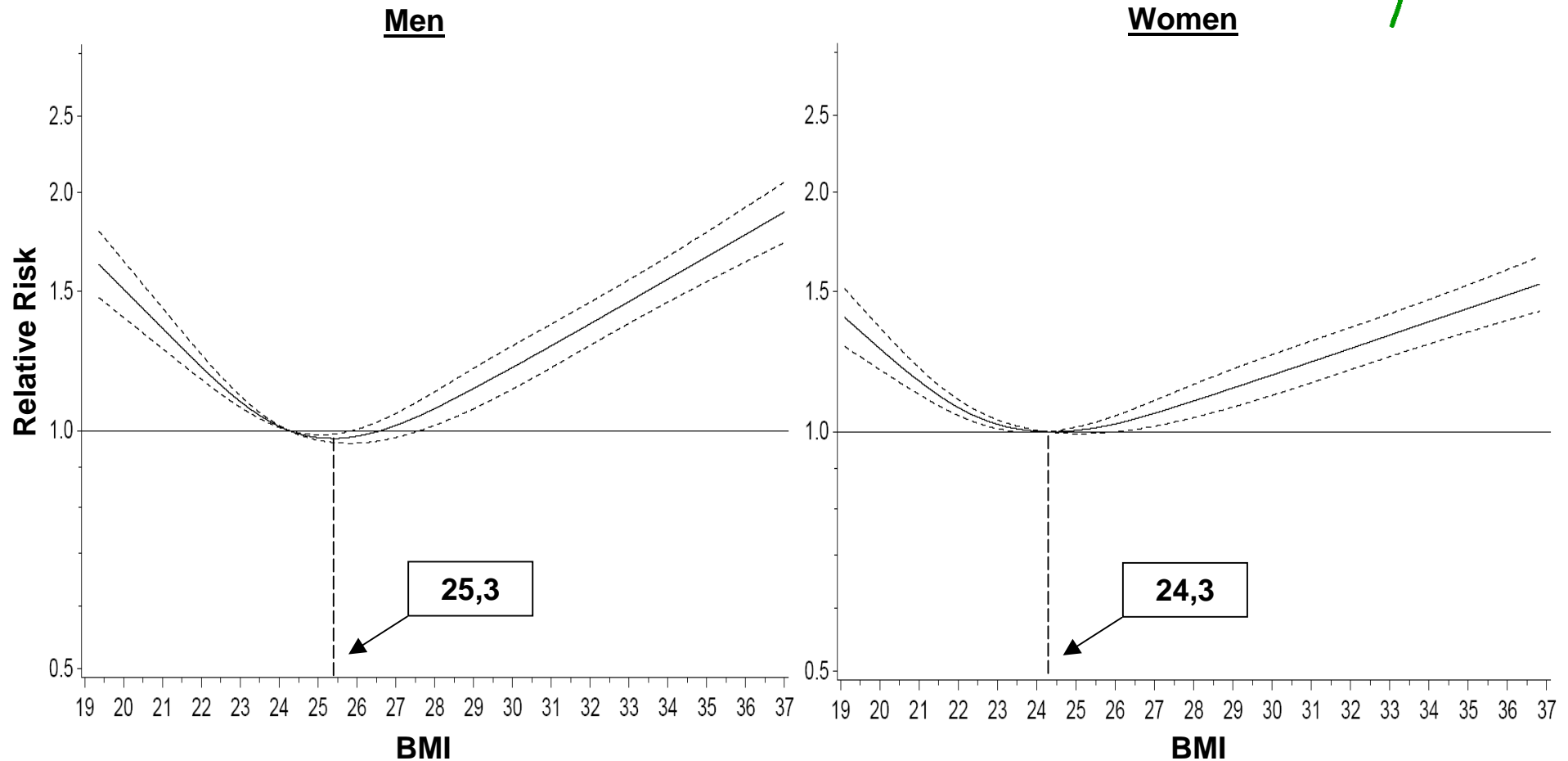
N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, and height
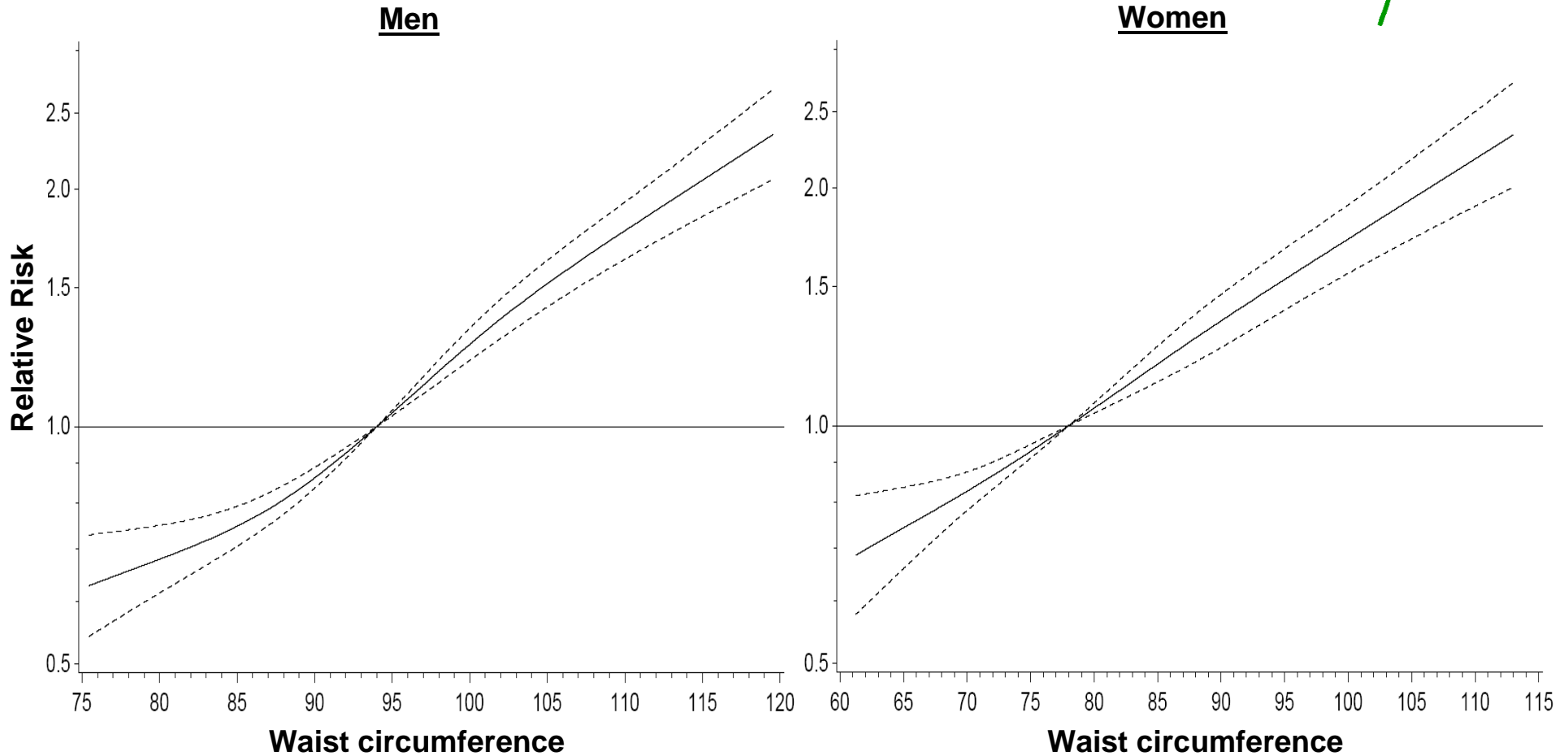
Pischon et al., N Engl J Med 2008

Association of Waist Circumference With Risk of Death in EPIC

Men

Women

Relative Risk (y-axis, Men panel): 0.5, 1.0, 1.5, 2.0, 2.5
Waist circumference (x-axis, Men panel): 75, 80, 85, 90, 95, 100, 105, 110, 115, 120

Waist circumference (x-axis, Women panel): 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115

N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, and height

Pischon et al., N Engl J Med 2008
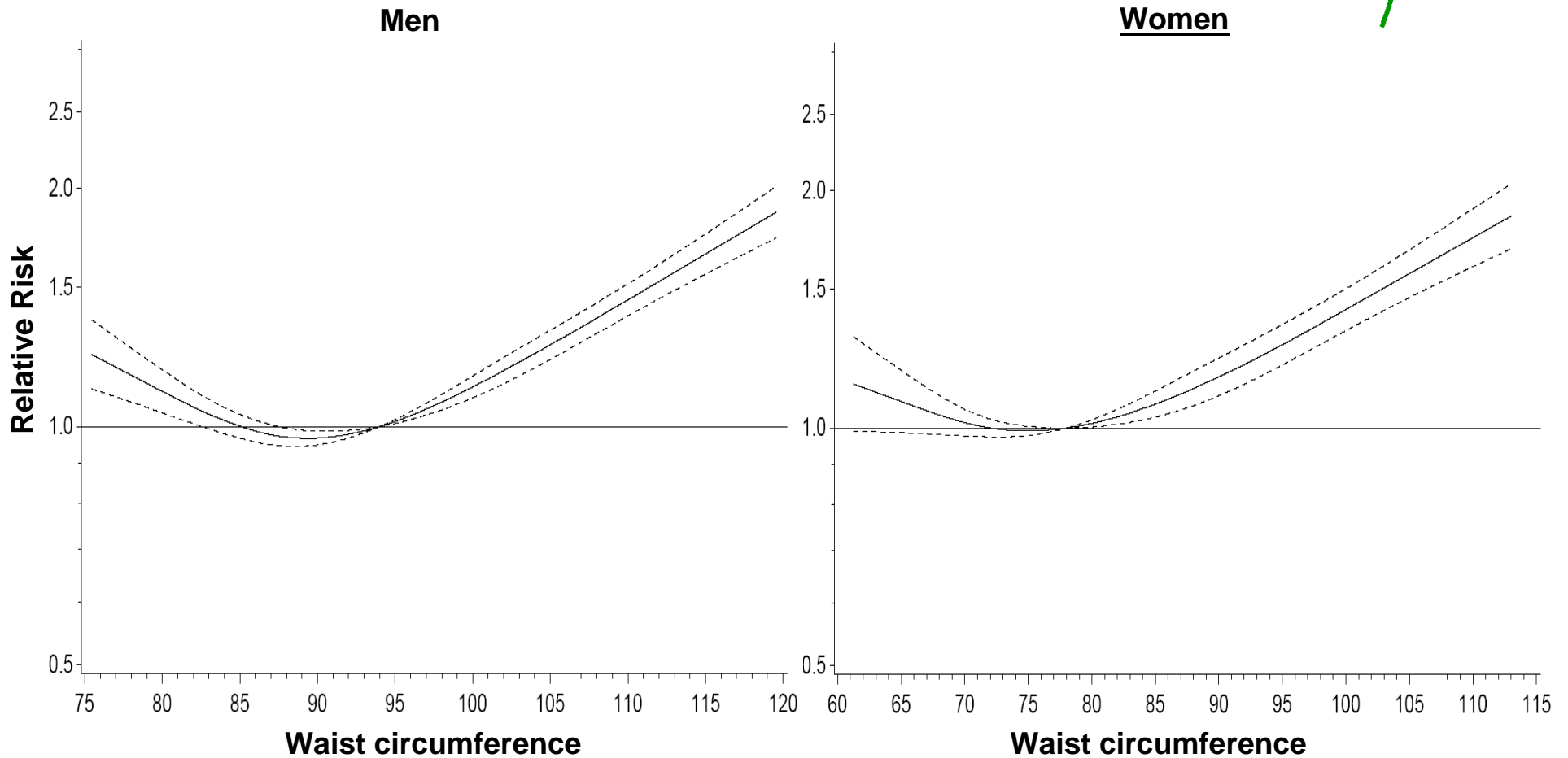
Association of Waist Circumference With Risk of Death After Adjustment for BMI
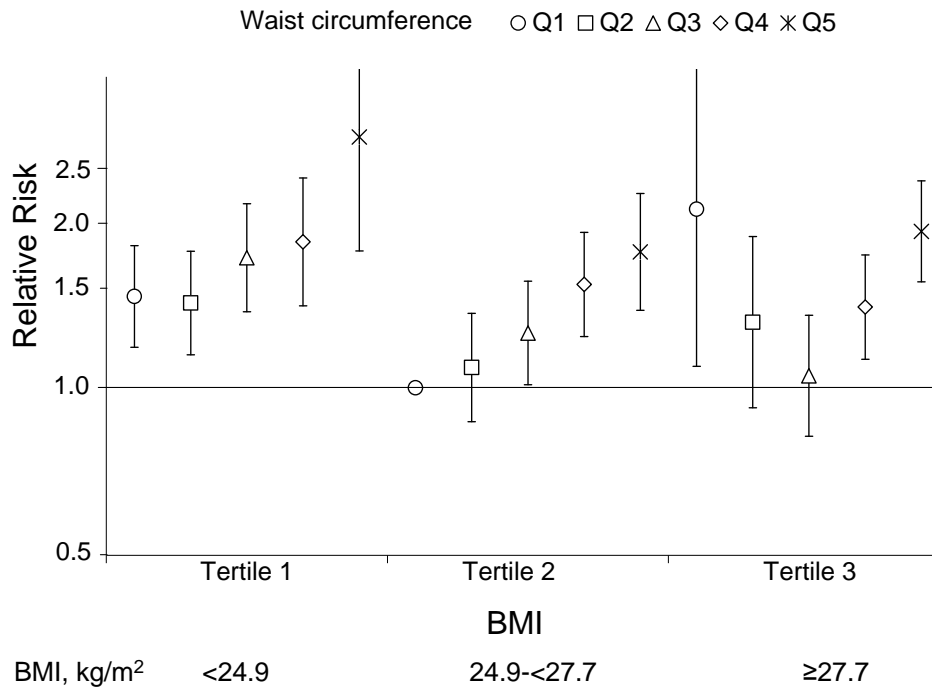

N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, height, and BMI
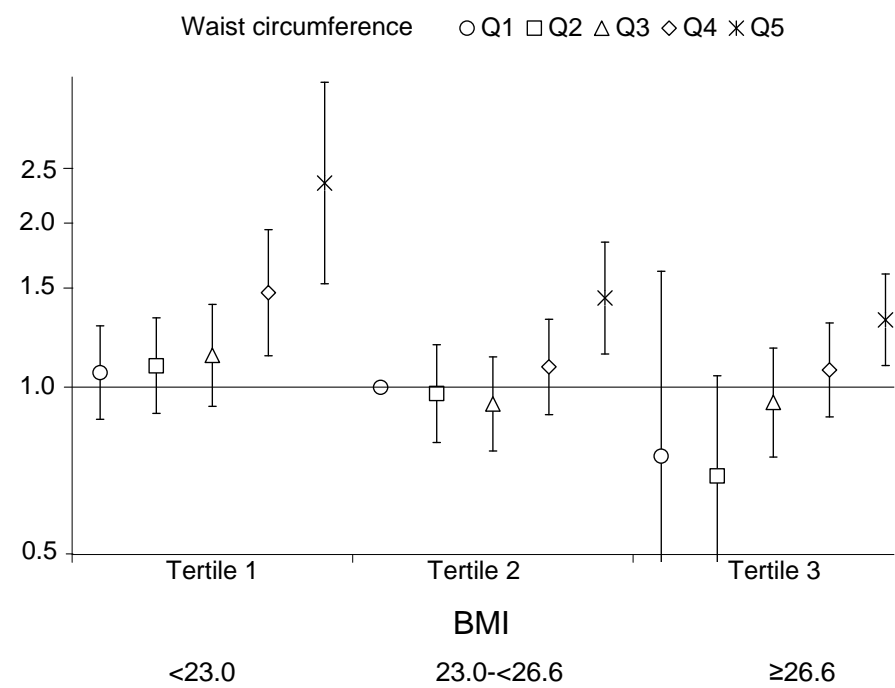
Pischon et al., N Engl J Med 2008

BMI, Waist Circumference and Risk of Death

N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, and height

Pischon et al., N Engl J Med 2008

Current Classification of Overweight and Obesity and Associated Disease Risk

Classification	BMI (kg/m^2)	Disease Risk According to Normal Weight and Waist Circumference	
		Men ≤ 102 cm Women ≤ 88 cm	Men > 102 cm Women > 88 cm
Underweight	<18.5	-	-
Normal weight	18.5-24.9	-	-
Overweight	25.0-29.9	Increased	High
Obesity Grade I	30.0-34.9	High	Very High
Obesity Grade II	35.0-39.9	Very High	Very High
Obesity Grade III	≥40.0	Extremely High	Extremely high

Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults - the evidence report - NIH PUBLICATION NO. 98-4083. Bethesda: National Institutes of Health; 1998

Association of BMI With Risk of Death in EPIC

N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, and height

Pischon et al., N Engl J Med 2008

Association of Waist Circumference With Risk of Death After Adjustment for BMI
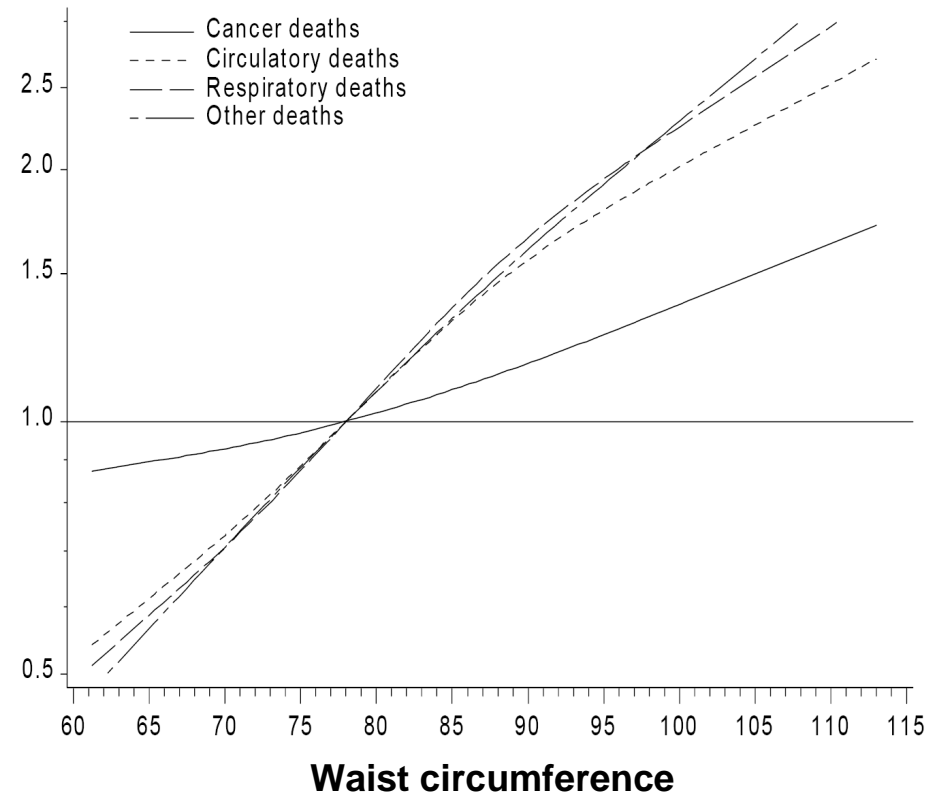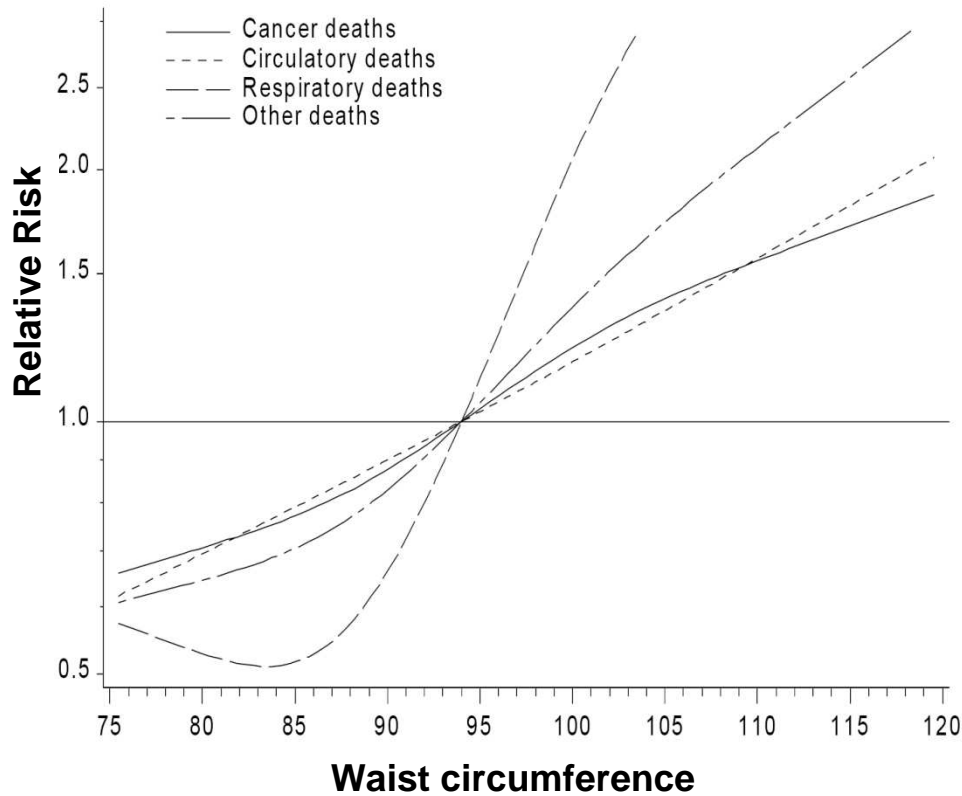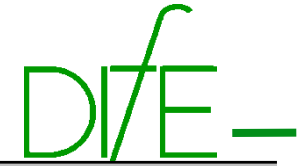
Men

Women

N=359,387; 9.7 years of follow-up; 14,723 deaths

Stratified by age and study center with adjustment for smoking status, education, alcohol consumption, physical activity, height, and BMI

Pischon et al., N Engl J Med 2008

Expected and Observed 5-Year Risk of Death (Men)

5-year risk according to model with BMI	5-year risk according to model with BMI and waist circumference				Total reclassified (%)
	<2.5%	2.5-<5.0%	5.0-<7.5%	>=7.5%	
<2.5%					
n	86,057	1,812	0	0	
Participants classified in stratum, %	97.9	2.1	0	0	2.1
Observed 5-year risk, %	0.9	2.4	-	-	
2.5-<5.0%					
n	1,943	17,403	950	1	
Participants classified in stratum, %	9.6	85.7	4.7	0	14.3
Observed 5-year risk, %	2.2	3.5	5.5	0	
5.0-<7.5%					
n	0	892	4,998	577	
Participants classified in stratum, %	0	13.8	77.3	8.9	22.7
Observed 5-year risk, %	-	4.7	7.0	7.8	
>=7.5%					
n	0	2	563	5,640	
Participants classified in stratum, %	0	0	9.1	90.9	9.1
Observed 5-year risk, %	-	0	7.8	14.2	

Pischon et al., N Engl J Med 2008

Calibration, Discrimination and Reclassification
(Men)

	Model with BMI	Model with BMI and Waist circumference	Model with BMI and Waist-hip-ratio
Nagelkerke's R^2, %	15.52	15.70	15.68
Hosmer-Lemeshow Statistic			
χ^2	11.91	14.18	10.09
p	0.16	0.08	0.26
C-statistic	0.7948	0.7961*	0.7964*†
Net reclassification index	-	0.00487 (p=0.41)	0.00042 (p=0.95)
Integrated discrimination index	-	0.00095 (p<0.0001)	0.00075 (p=0.004)

*p<0.05 versus model without waist circumference and waist-hip-ratio
†p<0.05 versus model with waist circumference

Pischon et al., N Engl J Med 2008

Summary and Conclusions

- General and abdominal adiposity are both associated with a higher risk of death

- J-shaped association between BMI and risk of death with higher risk in the lower and upper BMI categories than in the middle category

- Adjusted for BMI, there is an almost linear association between waist circumference and risk of death

- Positive association between abdominal adiposity and mortality is stronger at lower BMI levels than at higher BMI levels

- Measurement of waist circumference or waist-hip-ratio improves the prediction of mortality risk

- The results support the use of waist circumference or waist-to-hip ratio in addition to BMI in the assessment of the risk of death, particularly among persons with a low BMI