Long-term temporal trends in metabolic risk factors

Langfristige Trends bei metabolischen Risikofaktoren

Abstract

Objectives: The "metabolic syndrome" characterized by obesity, hypertension, dyslipidemia and hyperglycemia has consistently been associated with increased risk of cardiovascular disease. The aim of this study was to investigate long-term trends in major metabolic risk factors in three large cohorts.

Materials and Methods: Data from 239,602 individuals aged 25-64 years participating in health examinations from 1976 to 2005 were used to estimate prevalence and trends in risk factors.

Results: Irrespective of geographic location, single components of the metabolic syndrome showed divergent trends across the observation period. Whereas obesity and hyperglycemia increased by a per decade ratio of 1.54 (95%CI: 1.42-1.66) and 1.62 (95%CI: 1.49-1.76) in men and 1.48 (95%CI: 1.41-1.56) and 1.66 (95%CI: 1.57-1.75) in women, respectively, hypertension, decreased by 0.71 (95%CI: 0.68-0.74) in men and 0.83 (95%CI: 0.79-0.86 in women. Dyslipidemia showed non-linear pattern. Metabolic syndrome, defined as a combination of three of these risk factors, significantly increased by a ratio of 1.15 (95%CI: 1.08-1.22) and 1.20 (95%CI: 1.15-1.27) per decade in men and women, respectively.

Conclusion: This study showed that the single metabolic risk factors show divergent trends over the period of three decades even if Mets appeared to be stable over the last two decades. The two key components of the syndrome namely BMI and glucose levels, increased significantly deserving professional attention.

Key words: metabolic syndrome, body mass index, blood pressure, blood lipids, blood sugar

Introduction

The "metabolic syndrome" (MetS) was introduced in 1988 as a constellation of metabolic aberrations caused by overeating, sedentary life-style and other predispositions. Since its initial description, several definitions have been proposed [1, 2]. Despite differences in specific criteria among these definitions, there is wide agreement that the major characteristics of the syndrome include obesity, insulin resistance, hyperinsulinaemia, hyperglycaemia, high blood pressure, and dyslipidaemia. Presence of the MetS has consistently been associated with increased risk of cardiovascular disease, stroke and diabetes [3, 4]. There is also a growing body of literature indicating metabolic factors as risk elements for cancer incidence and mortality [5-12].

Epidemiologic evidence regarding long-term trends of single metabolic risk factors is limited. Trends of increasing BMI were consistently reported in studies covering a majority of European countries including the World Health Organisation (WHO) MONICA project [13-17] as well as the U.S. population [18-21] e.g. the NHANES surveys. More divergent results were published concerning blood pressure, cholesterol and triglycerides. The majority of studies showed a decreasing trend in blood pressure [13, 20-21], however a few studies have detected increasing trends [16-17,19]. Inconsistent trends were also observed for cholesterol [14-17,21] and triglycerides [14,19]. Smoking, not a metabolic but a major risk factor for cardiovascular and cancer disease, decreased especially in men in all western industrialized countries [14,20].

Differences in the compositions of the populations studied, limited length of observation periods and insufficient sample size may have contributed to a lack of consistent evidence in previous investigations. Based on the large sample size and an observation period covering 30 years, we aim to analyse if temporal trends in metabolic risk factors exist in different cohorts and health surveys across middle and northern Europe.

Material and Methods

The study population

The Me-Can collaborative study (Metabolic syndrome and Cancer project) was initiated in 2006, in order to create a large pooled cohort to investigate factors of the metabolic syndrome on the association with cancer risk. We used three sub-cohorts of the Me-Can collaborative study, mentioned below, from Austria and Sweden with total participants of 122,076 men and 117,526 women in the age range of 25-64 years. Whereas data from VHM&PP were used to show risk factor prevalence for Austria, VIP and Malmö provided data for Sweden. Although not necessarily representative for the whole country we merged data from Malmö and VIP in order to cover three decades of risk factor data for Sweden.

The Vorarlberg Health Monitoring and Prevention Programme (VHM&PP)

The VHM&PP is a population-based risk factor surveillance programme in Vorarlberg, the westernmost province in Austria [22-23]. The purpose of the programme was to prevent chronic diseases, foremost cardiovascular diseases and cancer, and it was routinely performed by the Agency for Social and Preventive Medicine. All adult residents in the region were invited by written invitations, television, radio or news papers, to participate in a health examination up to once a year. Since 1985, more than two-thirds of the population of the province participated in the programme. Data from the years 1985-2005 is included in Me-Can and during these years, the attendance rate in the VHM&PP was 66% and roughly 176 000 persons participated in the programme.

The Västerbotten Intervention Project (VIP)

The Västerbotten Intervention Project (VIP) is an ongoing project aiming for prevention of diabetes and cardiovascular disease in residents of Västerbotten county in the north of Sweden [24]. Since 1985, all residents are invited for a health check-up at 40, 50 and 60 years of age, and during the first ten years of the project, residents were also invited at the age of 30. The attendance rate has been 60% on average over the years. By the end of 2006, approximately 86,000 men and women had participated in the VIP.

The Malmö Preventive Project (MPP)

Middle-aged men and women in the city of Malmö in southern Sweden, were invited to a screening programme for prevention of cardiovascular disease and alcohol abuse.[25,26] Screenings were carried out between the years 1974-1992, to which all residents within predefined birth cohorts, born between 1921-1949, were invited. The attendance rate was on average 71% over the years. A total of 33,346 men and women participated in the baseline screening, and 5722 of these men (born 1926-1938) and 387 women (born in 1931) participated in a second screening in 1981-1989. The examination at the second screening was similar to that of the first screening.

Ethical approval

The study has been approved by ethical committees of the respective countries.

Measurements

Measurements include height, weight, systolic and diastolic blood pressure, serum total cholesterol, triglycerides, and glucose levels. Anthropometric measurements were conducted in all cohorts in a similar manner with participants wearing light indoor clothes and no shoes. Blood pressure was measured after 5-10 minutes of rest in sitting position in the VHM&PP and supine position in the VIP the MPP. Measurement was done with mercury sphygmomanometer in all cohorts. Serum measurements were performed after an overnight-fast of at least 8 hours in all individuals. Determination of glucose was done on serum in all cohorts except in MPP, where it was measured in whole blood. For determination of lipids, serum samples were used in all the cohorts. All the analysis was done using enzymatic technique.

The metabolic syndrome

To define the metabolic syndrome, we used a modified form of the National Cholesterol Education Programme Adult Treatment Panel (NCEP ATP III) [27] definition based on five commonly measured criteria: waist circumference (WC) which we replaced by BMI, blood pressure, serum triglycerides, serum high-density lipoprotein (HDL) cholesterol and fasting glucose level. In our study total cholesterol measurements were available instead of HDL-cholesterol. We used the following cut-off points: BMI $\geq$ 30 kg/m^2, hypertension defined as systolic blood pressure $\geq$ 140 mmHg and/or diastolic blood pressure $\geq$ 90 mmHg, hypercholesterolemia as total cholesterol > 6.1 mmol/l, hypertriglyceridaemia as triglycerides $\geq$ 1.69 mmol/l and fasting hyperglycaemia as fasting glucose $\geq$ 6.1 mmol/l. Any combination of three of the above conditions was defined as metabolic syndrome.

Statistical analysis

Total and region specific prevalence and means of metabolic risk factors were estimated by decades separately for men and women. Trends in metabolic risk factors were assessed by sex-specific linear and logistic regression analyses adjusted for age, region, smoking status and BMI where appropriate. For the logistic regression analyses risk factors were dichotomized in normal and elevated levels according to standard guidelines as reported above. The surveys included few participants above 65 years of age. Therefore, we restricted our analysis to the age range of 25-64 years. However, to further achieve balanced participation conform to the known population age distribution in this age range we applied sampling weights for the different cohorts using data from official census for the respective countries in the respective decade [28,29]. Sampling weights were calculated for 5-year age groups, separately for sex, decade and region. Results were summarized according to decades and the following regions: Austria (VHM&PP), and Sweden (VIP, MPP). SPSS Complex Samples 16.0 (SPSS Inc. Chicago, Il 2007) was used for statistical analysis.

Results

Estimated prevalence of the Mets and its components divided by regions and decades are shown in Table 2 for men and Table 3 for women. Mets defined as any combination of three elevated single risk factors increased from 10.3% to 15.8% in men and from 4.4% to 10.1% in women from the first to the second decade, followed by a very slight decrease from the second to the third decade (14.2% in men, 9.9% in women). Overall, prevalence of Mets increased by a ratio of 1.15 (95% CI: 1.08-1.22) and 1.20 (95% CI: 1.15-1.27) per decade, in men and women, respectively.

The single risk factors showed divergent trends across the three decades in both sexes (Tables 2, 3). The predominant trend was that obesity and impaired fasting glucose showed a strong increasing pattern whereas blood pressure lowered over the decades in both men and women. Dyslipidemia showed a less clear pattern. The prevalence of both hypercholesterolemia and hypertriglyceridemia increased from the first to the second decade and decreased from the second to the third. For hypercholesterolemia, values were significantly lower in the most recent decade; in the case of hypertriglyceridemia changes were not significant. Prevalence of smoking declined markedly in both men and women over the three decades. Regarding risk factor trends in the sub-regions, the observed results are similar to the overall results, with the exception of hypertension that decreased less pronounced in the Austrian survey compared to the Swedish surveys.

Trends in estimated means roughly confirmed the results of categorised risk factors. As shown in Tables 4 and 5 mean BMI and fasting glucose values for both regions increased significantly whereas diastolic blood pressure decreased and average cholesterol level remained stable. However, mean systolic blood pressure did not change significantly pointing to the possibility that the decrease in the prevalence of hypertension over the years is mainly due to control of diastolic blood pressure.

Discussion

The results of this analysis of three large-scale cohort datasets in two European countries provide further consistent evidence that metabolic risk factors followed divergent patterns across the past three decades. Whereas BMI and glucose levels increased uniformly, blood pressure and smoking decreased. Trends in blood lipids followed a non-linear pattern. Our findings concerning obesity are in agreement with all major studies performed in western industrialized countries [15-16, 30-31]. Similar obesity prevalence was reported for the European countries of the WHO MONICA project, albeit spanning a shorter time-period [15]. Whilst the magnitude of the increase of prevalence is markedly higher in the US, where the NHANES surveys showed that the age adjusted prevalence of obesity (BMI$\geq$ 30kg/m^2) rose from 29.1% in 1960-62 to 49.8% in 1999-2000 among the Afro-Americans and from 12.3% to 35.7% among Caucasians in the respective years [32], the direction of the trends are similar to our findings.

Our results for glucose, blood pressure and total cholesterol were also consistent with the reports from MONICA and NHANES. It has been argued recently that the forces driving these trends operate at the population rather than the individual level because this occurs across the percentile distribution [14, 31] and this between-country evidence we present here further supports that contention. Regarding hypertension, however, the few studies performed report conflicting outcomes [16, 20, 33]. This is a risk factor that can be strongly dependent on clinical hypertension detection and treatment follow-up and we demonstrate some differences between countries and cohorts that suggest this may indeed be important. Moreover, the zero-five-end digit preference might have contributed to the increase in the likelihood of classifying individuals as hypertensive as also seen else where [34]. Additionally it is suggested that both the baseline systolic and diastolic blood pressures were significantly higher in sitting position in both volunteers and hypertensive patients as compared to supine position [35]. This could, partly, be the case in our study where by the blood pressure values are higher in the Austrian cohorts as compared to the Swedish.

The pattern of lipid levels over time was not linear, and similarly, a previous study from Sweden showed an increase between 1985 and 1995, followed by a decline between 1995 and 2002 [15].

Prevalence of the MetS is strongly influenced by the different definitions proposed by the WHO, the NCEP or the IDF (International Diabetic Federation) [27]. Definitions overweighing glucose lead to increasing trends whereas other definitions show stable or even decreasing trends. Notably, whilst some risk factor trends are downwards and some conversely upwards, the net pattern for presence of three or more metabolic risk factors has in effect plateaued in the last decade. But the overall increasing tendency of metabolic syndrome was also observed in the NHANES surveys among US adults which also applied the ATPIII definition [19].

The implications of this may signal no net change in incidence of cardiovascular disease but a differing clinical presentation, whereas for cancer the implications may be quite different, especially given the strongly demonstrated association between obesity and cancer outcome in recent reports. Obesity was repeatedly shown to have positive association with overall and several site-specific malignancies including cancers of colorectum, endometrium, pancreas, kidney, gallbladder, thyroid and oesophagus [6-8]. Furthermore, obesity was shown to be associated with high prostate and breast cancer mortality [9, 10]. High glucose levels were also linked to an increased overall risk of cancer [11-12].

Our study had several strengths and potential limitations that should be considered. Major strengths are the large sample size, length of observation period and the comparable protocols between middle and northern European health surveys that were used assessing the data. Measurements were in general very similar, but there were some exceptions. Blood sample for glucose determination was serum in VHM&PP and in VIP and whole blood in MPP.

Additionally, blood pressure was measured in sitting position in VHM&PP and in supine position in VIP and MPP. These may well affect our results, however, we think to a minor extent. A further limitation of the study is the inability to examine the effect of treatment, mainly medication of high blood pressure, cholesterol and diabetes. In addition, we were unable to account for the effect of behavioural changes regarding diet, alcohol consumption or physical activity.

This study showed that the single metabolic risk factors show divergent trends over the period of three decades even if Mets appeared to be stable over the last two decades. The fact that the key components of MetS, namely BMI and glucose levels, increased significantly deserves wide spread recognition by policy makers and those concerned with health promotion and disease prevention.

References

1. Daskalopoulou SS, Athyros VG, Kolovou GD, Anagnostopoulou KK, Mikhailidis DP. Definitions of metabolic syndrome: Where are we now? Curr Vasc Pharmacol. 2006 ; 4(3):185-97.
2. Li C, Ford ES. Definition of the Metabolic Syndrome: What's New and What Predicts Risk? Metab Syndr Relat Disord 2006; 4(4):237-51.
3. Ford E.S. Risks for all-cause mortality, cardiovascular disease, and diabetes associated with the metabolic syndrome: a summary of the evidence. Diabetes Care 2005; 28(7): 1769-78.
4. Lorenzo C, Williams K, Hunt KJ, Haffner SM. The National Cholesterol Education Programme - Adult Treatment Panel III, International Diabetes Federation, and World Health Organization definitions of the metabolic syndrome as predictors of incident cardiovascular disease and diabetes. Diabetes Care 2007; 30(1): 8-13.
5. Cowey S, Hardy RW. The metabolic syndrome: A high-risk state for cancer? Am J Pathol 2006; 169(5): 1505-22.
6. Lukanova A, Björ O, Kaaks R, Lenner P, Lindahl B, Hallmans G, et al. Body mass index and cancer: results from the Northern Sweden Health and Disease Cohort. Int J Cancer 2006; 118(2): 458-66.
7. Rapp K, Schroeder J, Klenk J, Stoehr S, Ulmer H, Concin H, et al. Obesity and incidence of cancer: a large cohort study of over 145,000 adults in Austria. Br J Cancer 2005; 93(9): 1062-7.
8. Renehan AG, Tyson M, Egger M, Heller ReeF, Zwahlen M. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. Lancet 2008; 371(9612):569-78
9. MacInnis, RJ. English DR. Body size and composition and prostate cancer risk: systematic review and meta-regression analysis. Cancer Causes Control 2006; 17(8): 989-1003.
10. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 2003; 348(17): 1625-38.
11. Manjer J, Kaaks R, Riboli E, Berglund G. Risk of breast cancer in relation to anthropometry, blood pressure, blood lipids and glucose metabolism: a prospective study within the Malmö Preventive Project. Eur J Cancer Prev 2001; 10(1): 33-42.
12. Rapp K, Schroeder J, Klenk J, Ulmer H, Concin H, Diem G, et al. Fasting blood glucose and cancer risk in a cohort of more than 140,000 adults in Austria. Diabetologia 2006; 49(5): 945-52.
13. Tunstall-Pedoe H, Connaghan J, Woodward M, Tolonen H, Kuulasmaa K. Pattern of declining blood pressure across replicate population surveys of the WHO MONICA project, mid-1980s to mid-1990s, and the role of medication. BMJ 2006; 332(7542):629-35.
14. Berg CM, Lissner L, Aires N, Lappas G, Toren K, Wilhelmsen L et al. Trends in blood lipid levels, blood pressure, alcohol and smoking habits from 1985 to 2002: results from INTERGENE and GOT-MONICA. European Journal of Cardiovascular Prevention & Rehabilitation 2005; 12(2):115-125.

15. Evans A, Tolonen H, Hense HW, Ferrario M, Sans S, Kuulasmaa K; WHO MONICA Project. Trends in coronary risk factors in the WHO MONICA project. Int J Epidemiol. 2001; 30 Suppl 1: 35-40.
16. Basterra-Gortari FJ, Bes-Rastrollo M, Seguí-Gómez M, Forga L, Martínez JA, Martínez-González MA. Trends in obesity, diabetes mellitus, hypertension and hypercholesterolemia in Spain (1997-2003). Med Clin (Barc) 2007; 129(11):405-8.
17. Serra-Majem L, Pastor-Ferrer MC, Castell C, Ribas-Barba L, Román-Viñas B, Ribera LF, Plasencia A, Salleras L. Trends in blood lipids and fat soluble vitamins in Catalonia, Spain (1992-2003). Public Health Nutr 2007; 10(11A):1379-88.
18. Ford ES, Giles WH, Dietz WH: Prevalence of Metabolic Syndrome Among US Adults: findings from the Third National Health and Nutrition examination Survey. JAMA 2002; 287:356-359.
19. Ford ES, Giles WH, Mokdad AH: Increasing prevalence of metabolic syndrome among US adults. Diabetic Care 2004; 27: 2444-2449.
20. Gregg EW, Cheng YJ, Cadwell BL, Imperatore G, Williams DE, Flegal KM, et al. Secular trends in cardiovascular disease risk factors according to body mass index in US adults. JAMA 2005; 293(15):1868-74.
21. Goff DC, Howard G, Russell GB, Labarthe DR; et al. Birth cohort evidence of population influences on blood pressure in the United States. Ann Epidemiol 2001; 11(4):271-9.
22. Ulmer H, Kelleher C, Diem G, Concin H. Long-term tracking of cardiovascular risk factors among men and women in a large population-based health system: the Vorarlberg Health Monitoring & Promotion Programme. Eur Heart J 2003; 24(11): 1004-13.
23. Ulmer H, Kelleher C, Diem G, Concin H, Ruttmann E. Estimation of seasonal variations in risk factor profiles and mortality from coronary heart disease. Wien Klin Wochenschr. 2004;116(19-20):662-8.
24. Lindahl B, Weinehall L, Asplund K, Hallmans G. Screening for impaired glucose tolerance. Results from a population-based study in 21,057 individuals. Diabetes Care 1999; 22(12):1988-92.
25. Berglund G, Eriksson KF, Israelsson B, Kjellström T, Lindgärde F, Mattiasson I, et al. Cardiovascular risk groups and mortality in an urban Swedish male population: the Malmo Preventive Project. J Intern Med 1996; 239(6): 489-97.
26. Berglund G, Nilsson P, Eriksson KF, Nilsson JA, Hedblad B, Kristenson H, et al. Long-term outcome of the Malmo preventive project: mortality and cardiovascular morbidity. J Intern Med 2000; 247(1): 19-29.
27. Grundy SM, Brewer HB Jr, Cleeman JI, Smith SC Jr, Lenfant C. Definition of metabolic syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. Circulation 2004; 109: 433–438.
28. Statistik Austria-Statistiken http://www.statistik.at/. Accessed 2009.01.10
29. Statistics Sweden. http://www.scb.se/default____2154.asp. Accessed 2009.01.10
30. Ulmer H, Diem G, Bischof HP, Ruttmann E, Concin H. Recent trends and sociodemographic distribution of cardiovascular risk factors: results from two population surveys in the Austrian WHO CINDI demonstration area. Wien Klin Wochenschr. 2001 Aug 16;113(15-16):573-9.
31. Ulmer H, Kelleher CC, Fitz-Simon N, Diem G, Concin H. Secular trends in cardiovascular risk factors: an age-period cohort analysis of 698,954 health examinations in 181,350 Austrian men and women. J Intern Med 2007; 261(6):566-76.

32. Okosun IS, Chandra KM, Boev A, Boltri JM, Choi ST, Parish DC, et al. Abdominal adiposity in U.S. adults: prevalence and trends, 1960-2000. Prev Med 2004; 39(1):197-206.
33. Park HS, Kim SM, Lee JS, Lee J, Han JH, Yoon DK, et al. Prevalence and trends of metabolic syndrome in Korea: Korean National Health and Nutrition Survey 1998-2001. Diabetes Obes Metab 2007; 9(1):50-8.
34. Broad J, Wells S, Marshall R, Jackson R. Zero end-digit preference in recorded blood pressure and its impact on classification of patients for pharmacologic management in primary care - PREDICT-CVD-6. Br J Gen Pract 2007; 57(544):897-903.
35. Malhotra S, Malhotra AS, Pandhi P. Supine versus sitting blood pressure in healthy volunteers and hypertensive patients before and after calcium antagonist treatment. Indian Journal of Physiology and Allied Sciences. 2000; 54(1): 27-33.

Table 1. Sociodemographic characteristics of the study population

Cohort	No. of participants			Mean age (std.)*	
	men	women	total	men	women
VHM&PP (Austria)					
76-85	-	-	-	-	-
86-95	42,263	49,094	91,357	42.6 (11.1)	42.8 (11.3)
96-05	23,054	21,339	44,393	40.7 (11.0)	39.8 (10.9)
Malmö (Sweden)					
76-85	22,241	6,750	28,991	43.7 (6.6)	46.6 (7.7)
86-95	-	3,774	3,774	-	54.8 (2.1)
96-05	-	-		-	
VIP (Sweden)					
76-85	-	-	-	-	-
86-95	12,597	14,194	26,791	45.4 (10.4)	45.5 (10.4)
96-05	21,921	22,375	44,296	48.8 (8.4)	48.7 (8.5)

* Only participants between 25 and 64 years of age were included.

Table 2. Total and region-specific prevalence of metabolic risk factors and smoking by decades in men aged 25-64 years, Austria, Sweden 1976-2005

No. of participants	decades	obesity*	hypertension	hypercholeste-rolemia	hypertrigly-ceridemia	fasting hyperglycemia	3 or more factors (modified ATP)	smoking
Total								
n=22,241	76-85	6.1 †	43.0	27.1	26.2	4.7	10.3	47.9
n=54,860	86-95	9.8	35.5	34.7	35.0	8.7	15.8	24.7
n=44,975	96-05	14.1	33.9	25.4	30.7	13.6	14.2	19.8
	OR (95% CI)	1.54 (1.42-1.66)††	0.71 (0.68-0.74)	0.87 (0.83-0.91)	0.98 (0.94-1.03)	1.62 (1.49-1.76)	1.15 (1.08-1.22)	0.54 (0.52-0.57)
	p for trend	<0.001	<0.001	<0.001	0.278	<0.001	<0.001	<0.001
Austria								
-	76-85	-	-	-	-	-	-	-
n=42,263	86-95	9.7	42.0	34.2	38.7	8.2	16.8	32.2
n=23,054	96-05	14.2	40.5	24.4	34.7	12.6	16.0	25.5
Sweden								
n=22,241	76-85	6.1	43.0	27.1	26.2	4.7	10.3	47.9
n=12,597	86-95	9.8	28.8	34.9	30.1	9.0	13.9	17.8
n=22,921	96-05	13.8	27.2	26.1	26.3	14.2	12.1	14.4

* Obesity was defined as BMI ≥30 kg/m², hypertension as sytolic blood pressure of ≥140 mmHg or diastolic ≥90 mmHg, hypercholesterolemia > 6.1 mmol/l, hypertriglyceridemia ≥1.69 mmol/l and hyperglycemia >6.1 mmol/l.

†Percentages estimated using region-,decade-,and sex-specific 5-year age-group sampling weights (complex samples).

†† Ratio of change per decade, estimated from logistic regression models for complex samples adjusted for age, region, smoking and body-mass-index where appropriate.

Table 3. Total and region-specific prevalence of metabolic risk factors and smoking by decades in women aged 25-64 years, Austria, Sweden 1976-2005

No. of participants	decades	obesity*	hypertension	hypercholeste-rolemia	hypertrigly-ceridemia	fasting hyperglycemia	3 or more factors (modified ATP)	smoking
Total								
n=6,750	76-85	6.6 †	25.4	24.2	11.8	1.8	4.4	39.7
n=67,062	86-95	11.4	27.7	28.0	17.4	6.4	10.1	23.2
n=43,714	96-05	15.6	26.5	22.6	15.7	9.3	9.9	17.9
	OR (95% CI)	1.48 (1.41-1.56)††	0.83 (0.79-0-86)	0.82 (0.80-0.86)	0.99 (0.94-1.03)	1.66 (1.57-1.75)	1.20 (1.15-1.27)	0.61 (0.59-0.63)
	p for trend	<0.001	<0.001	<0.001	0.439	<0.001	<0.001	<0.001
Austria								
-	76-85	-	-	-	-	-	-	-
n=49,094	86-95	11.4	33.3	27.6	18.2	6.4	10.9	23.5
n=21,339	96-05	16.3	30.5	21.2	16.7	8.5	10.6	18.4
Sweden								
n=6,750	76-85	6.6	25.4	24.2	11.8	1.8	4.4	39.7
n=17,968	86-95	11.0	20.9	28.2	16.0	6.2	8.6	23.4
n=22,375	96-05	14.5	21.7	23.3	14.4	9.8	8.7	17.7

* Obesity was defined as BMI ≥30 kg/m², hypertension as sytolic blood pressure of ≥140 mmHg or diastolic ≥90 mmHg, hypercholesterolemia > 6.1 mmol/l, hypertriglyceridemia ≥1.69 mmol/l and hyperglycemia >6.1 mmol/l.

†Percentages estimated using region-,decade-,and sex-specific 5-year age-group sampling weights (complex samples).

†† Ratio of change per decade, estimated from logistic regression models for complex samples adjusted for age, region, smoking and body-mass-index where appropriate.

Table 4. Total and region-specific means (95% CI) of metabolic risk factors by decades in men aged 25-64 years, Austria, Sweden 1976-2005

cohort	decades†	BMI, kg/sqm	systolic blood pressure, mmHg	diastolic blood pressure, mmHg	total cholesterol, mmol/l	triglycerides, mmol/l	fasting glucose, mmol/l
Total							
n=22,241	76-85	24.5 (24.4-24.7)*	128.4 (127.7-129.0)	85.0 (84.7-85.5)	5.6 (5.5-5.6)	1.5 (1.4-1.5)††	5.1 (5.0-5.2)
n=54,860	86-95	25.6 (25.5-25.6)	129.7 (129.5-129.9)	81.1 (81.0-81.2)	5.7 (5.7-5.7)	1.7 (1.7-1.7)	5.1 (5.1-5.1)
n=44,975	96-05	26.2 (26.1-26.3)	129.9 (129.6-130.1)	80.6 (80.4-80-8)	5.5 (5.5-5.5)	1.6 (1.6-1.6)	5.4 (5.4-5.4)
	p for trend	<0.001†	0,011	<0.001	<0.001	0.24	<0.001
Austria							
-	76-85	-	-	-	-	-	-
n=42,263	86-95	25.5 (25.4-25.5)	131.4 (131.2-131.6)	82.5 (82.4-82.6)	5.7 (5.7-5.7)	1.8 (1.8-1.8)	4.8 (4.8-4.8)
n=23,054	96-05	26.0 (26.0-26.1)	132.2 (131.9-132.5)	82.2 (82.0-82.3)	5.6 (5.6-5.6)	1.7 (1.7-1.7)	5.3 (5.2-5.3)
Sweden							
n=22,241	76-85	24.5 (24.4-24.7)	128.4 (127.5-128-2)	85.1 (84.7-85.5)	5.6 (5.5-5.6)	1.5 (1.4-1.5)	5.1 (5.0-5.2)
n=12,597	86-95	25.7 (25.6-25-7)	127.8 (127.5-128.2)	79.7 (79.5-80.0)	5.7 (5.7-5.7)	1.5 (1.5-1.6)	5.3 (5.3-5.4)
n=22,921	96-05	26.3 (26.2-26.4)	127.5 (127.1-127.9)	79.1 (78.8-79.3)	5.4 (5.4-5.5)	1.5 (1.4-1.5)	5.5 (5.5-5.6)

*Means (95% CI) estimated using region-,decade-,and sex-specific 5-year age-group sampling weights (complex samples).

† Effect of decade (p for trend) was tested in linear regression analyses for complex samples adjusted for age, region, smoking and body-mass-index where appropriate. In case of non linear pattern (lipids) p-values were given comparing 3rd versus 1st decade.

†† Triglycerides were log-transformed, means thus obtained represent geometric means.

Table 5. Total and region-specific means (95% CI) of metabolic risk factors by decades in women aged 25-64 years, Austria, Sweden 1976-2005

cohort	decades†	BMI, kg/sqm	systolic blood pressure, mmHg	diastolic blood pressure, mmHg	total cholesterol, mmol/l	triglycerides, mmol/l	fasting glucose, mmol/l
Total							
n=6,750	76-85	23.4 (23.2-23.5)*	121.2 (120.7-121.7)	80.6 (80.3-80.9)	5.5 (5.5-5.5)	1.1 (1.1-1.1) ††	4.8 (4.7-4.8)
n=67,062	86-95	24.7 (24.6-24.7)	125.1 (124.9-125.3)	78.3 (78.2-78.4)	5.5 (5.5-5.5)	1.3 (1.2-1.3)	5.0 (5.0-5.0)
n=43,714	96-05	25.3 (25.2-25.4)	125.0 (124.7-125.3)	77.4 (77.2-77-6)	5.4 (5.4-5.4)	1.2 (1.2-1.2)	5.2 (56.2-5.3)
	p for trend	<0.001†	0.512	<0.001	<0.001	0.288	<0.001
Austria							
-	76-85	-	-	-	-	-	-
n=49,094	86-95	24.4 (24.4-24.5)	127.1 (126.9-127.3)	80.0 (79.8-80.1)	5.5 (5.5-5.5)	1.3 (1.3-1.3)	4.7 (4.7-4.7)
n=21,339	96-05	25.1 (25.0-25.2)	126.6 (126.2-126.9)	79.0 (78.8-79.2)	5.4 (5.4-5.5)	1.2 (1.2-1.2)	5.0 (5.0-5.1)
Sweden							
n=6,750	76-85	23.4 (23.2-23.5)	121.2 (120.7-121.7)	80.6 (80.3-80.9)	5.5 (5.5-5.5)	1.1 (1.1-1.1)	4.8 (4.7-4.8)
n=17,968	86-95	24.8 (24.7-24.9)	122.5 (122.2-122.8)	76.5 (76.3-76.7)	5.5 (5.5-5.5)	1.2 (1.2-1.2)	5.2 (5.2-5.2)
n=22,375	96-05	25.4 (25.3-25.6)	123.0 (122.6-123.4)	75.6 (75.3-75.9)	5.4 (5.3-5.4)	1.2 (1.2-1.2)	5.4 (5.4-5.4)

*Means (95% CI) estimated using region-,decade-,and sex-specific 5-year age-group sampling weights (complex samples).

† Effect of decade (p for trend) was tested in linear regression analyses for complex samples adjusted for age, region, smoking and body-mass-index where appropriate. In case of non linear pattern (lipids) p-values were given comparing 3rd versus 1st decade.

†† Triglycerides were log-transformed, means thus obtained represent geometric means.