

Risk Factors of the Metabolic Syndrome and Cancer Outcomes in a Large Primary Prevention Programme

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The metabolic syndrome was introduced in 1988 as a constellation of metabolic aberrations caused by overeating and sedentary lifestyle. The metabolic syndrome includes obesity, hyperglycaemia, high blood pressure, and dyslipidaemia and its presence has been consistently associated with an increased risk of cardiovascular disease, stroke and diabetes. Only a few studies of sufficient sample size have examined the link between risk factors of the metabolic syndrome and cancer.

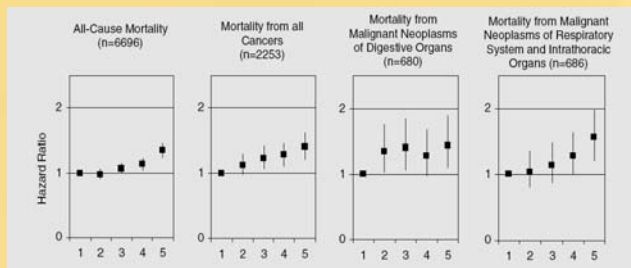
Since 1985, residents of Vorarlberg, the westernmost province in Austria, above 19 years of age, have been invited to yearly health check-ups for disease prevention. As of 2005, more than 180,000 individuals have participated in this so called Vorarlberg Health Monitoring and Promotion Programme (VHM&PP), with 1-21 examinations per individual resulting in a total of almost 700,000 examinations. The VHM&PP cohort has been linked to the regional Vorarlberg cancer registry for cancer incidence outcomes as well as to the Austrian National cause of death registry for mortality outcomes.

Recent research of our group has shown associations of varying strengths of body mass index(1), fasting serum glucose(2), uric acid (3,4) and gamma-glutamyl transferase(5,6) with cancer outcomes at different sites. Our results aid to the understanding of the role of metabolic and lifestyle risk factors in cancer development supporting their use as valuable measures in not exclusively cardiovascular but also cancer prevention.

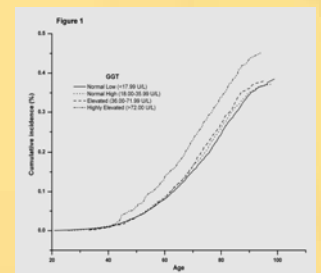
BMI and Cancer Incidence in Women

Type of cancer	BMI kg/m ²					P for trend
	16.5–24.9 49 (34.5) (40.7)	25–29 20 (14.3) (38.7)	30–34.9 47 (34.0) (37.6)	≥ 35 13 (9.2) (34.7)		
All cancers	143 (71.7)	100 (50.0)	304 (90.9)	113 (76.7)		0.008
All non-CG	126 (63.3)	120 (60.0)	314 (95.4)	118 (78.7)		
Non-Hodgkin lymphoma	36 (18.1)	37 (18.5)	28 (8.5)	13 (8.7)		0.48
Other cancer (ICD-9 15)	123 (61.6)	120 (60.0)	286 (86.9)	105 (70.0)		
Leukemia	123 (61.6)	120 (60.0)	286 (86.9)	105 (70.0)		
Myeloid cancer (ICD-9 16)	68 (34.0)	67 (33.5)	132 (40.6)	53 (35.3)		0.32
Lymphoid cancer (ICD-9 16)	123 (61.6)	120 (60.0)	286 (86.9)	105 (70.0)		
Hematologic cancer (ICD-9 16)	123 (61.6)	120 (60.0)	286 (86.9)	105 (70.0)		
Solid cancer (ICD-9 16)	123 (61.6)	120 (60.0)	286 (86.9)	105 (70.0)		
Breast cancer (ICD-9 17)	29 (14.5)	21 (10.5)	14 (4.3)	7 (4.7)		0.4
Prostate cancer (ICD-9 18)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Colon cancer (ICD-9 19)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Rectal cancer (ICD-9 20)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Stomach cancer (ICD-9 21)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Pancreatic cancer (ICD-9 22)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Liver cancer (ICD-9 23)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Lung cancer (ICD-9 24)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Bladder cancer (ICD-9 25)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Kidney cancer (ICD-9 26)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Testicular cancer (ICD-9 27)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Ovarian cancer (ICD-9 28)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Uterine cancer (ICD-9 29)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Cervical cancer (ICD-9 30)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Vaginal cancer (ICD-9 31)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Penile cancer (ICD-9 32)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Anal cancer (ICD-9 33)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Thyroid cancer (ICD-9 34)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Parathyroid cancer (ICD-9 35)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Adrenal cancer (ICD-9 36)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Pituitary cancer (ICD-9 37)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Hypothalamic cancer (ICD-9 38)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Brain cancer (ICD-9 39)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Nerve cancer (ICD-9 40)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue cancer (ICD-9 41)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Bone cancer (ICD-9 42)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 43)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Bone sarcoma (ICD-9 44)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 45)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 46)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 47)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 48)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 49)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 50)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 51)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 52)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 53)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 54)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 55)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 56)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 57)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 58)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 59)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 60)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 61)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 62)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 63)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 64)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 65)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 66)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 67)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 68)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 69)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 70)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 71)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 72)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 73)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 74)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 75)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 76)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 77)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 78)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 79)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 80)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 81)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 82)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 83)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 84)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 85)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 86)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 87)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 88)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 89)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 90)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 91)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 92)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 93)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 94)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 95)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 96)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 97)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 98)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 99)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 100)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 101)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 102)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 103)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 104)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 105)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 106)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 107)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 108)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 109)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 110)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 111)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 112)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 113)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 114)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 115)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 116)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 117)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 118)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 119)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 120)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 121)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 122)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 123)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 124)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 125)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 126)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 127)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 128)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 129)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 130)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 131)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 132)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 133)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 134)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 135)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 136)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 137)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 138)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 139)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 140)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 141)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 142)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 143)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 144)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 145)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 146)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 147)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 148)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 149)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 150)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 151)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 152)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 153)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 154)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 155)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 156)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 157)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 158)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 159)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 160)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 161)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 162)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 163)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 164)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue carcinoma (ICD-9 165)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		
Soft tissue sarcoma (ICD-9 166)	44 (22.0)	43 (21.5)	58 (17.9)	27 (18.0)		

Uric Acid and Cancer Mortality in Men



GGT and Cancer Incidence in Women



Fasting Glucose and Cancer Incidence

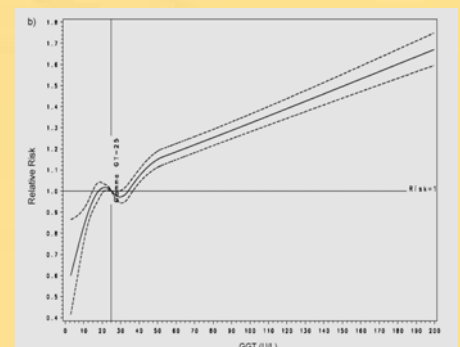
	Fasting blood glucose (mmol/l) ^b														<i>p</i> for trend ^d	
	2.2-4.1			4.2-5.2		5.3-6.0		6.1-6.9			≥7.0					
	<i>n</i>	HR	95% CI	<i>n</i>	HR	<i>n</i>	HR	95% CI	<i>n</i>	HR	95% CI	<i>n</i>	HR	95% CI		
Total participants	36,087			69,720			23,420			6,828			4,758			
Liver cancer	12	1.37	0.67-2.83	19	1.00		14	1.89	0.94-3.79	7	2.45	1.02-5.89	9	3.56	1.58-8.02	0.003
Gallbladder and bile duct cancer	5	0.92	0.32-2.62	12	1.00		9	1.90	0.80-4.54	7	3.74	1.46-9.58	5	3.35	1.16-9.70	0.002
Thyroid cancer	15	1.24	0.65-2.37	24	1.00		19	2.22	1.21-4.07	12	2.34	1.15-4.78	–			0.02
Multiple myeloma	11	1.54	0.71-3.37	15	1.00		13	2.26	1.07-4.77	9	2.42	1.04-5.61	–			0.09
Leukaemia	12	0.78	0.39-1.55	31	1.00		16	1.41	0.76-2.59	8	1.00	0.46-2.22	–			0.37

^aCox proportional-hazards models stratified according to age and adjusted for smoking status (never, former, current), occupational group (white collar, blue collar, self-employed), and

^bGlucose categories (6.1–6.9 and ≥ 7.0 mmol/l) were combined as needed to ensure at least five cases in each exposure group

*Trend test *p* value corresponds to Wald *p* value for ordinal coefficient for glucose coded according to the median glucose level for each exposure category

GGT and Cancer Incidence in Men



(1) Rapp K, Schroeder J, Klenk J, Stoehr S, Ulmer H, Concin H, Diem G, Oberaigner W, Weiland SK. Obesity and incidence of cancer: a large cohort study of over 145,000 adults in Austria. *British Journal of Cancer*. 2005;93(9):1062-7.

(2) Rapp K, Schroeder J, Klenk J, Ulmer H, Concin H, Diem G, Oberaigner W, Weiland SK. Fasting blood glucose and cancer risk in a cohort of more than 140,000 adults in Austria. *Diabetologia*. 2006;49(5):945-52.

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