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Changes of body mass index in relation to mortality: results of a cohort of 42,099 adults

Background

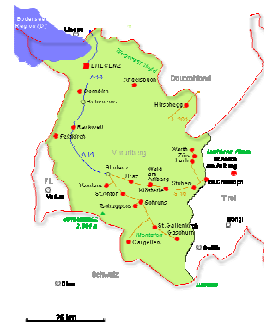
- Obesity is associated with increased all-cause mortality
- little is known about the effect of short- and long-term (Body-Mass-Index) BMI change on mortality

Objective

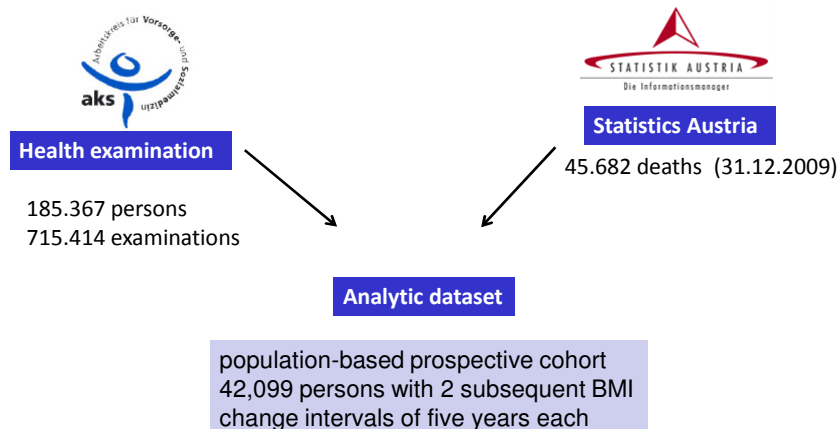
to determine how long-term BMI change affects mortality

Vorarlberg Health Monitoring and Prevention Program (VHM&PP)

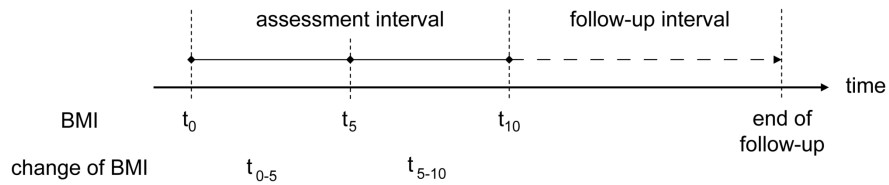
- population-based risk factor surveillance programme in Vorarlberg
- aim: prevention of cardiovascular disease and cancer
- target population: residents from the age of 19 years
- health examinations performed by physicians :
 - height, weight and blood pressure measurement
 - blood sample for analyses of blood glucose, total cholesterol, triglycerides, uric acid and GGT
 - interview
- data electronically available since 1985
- participation rate about 60%



Study population –follow-up



BMI change – time scale



Median follow-up time : 11.8 years

Statistical Methods

Inclusion criteria:

Baseline BMI $\geq 18,5$ kg/m²

Exposure variables:

Body mass index (BMI)

changes of BMI over 10 years by 5 years increments

Covariates:

Smoking status, age at recruitment (year)

Statistical method:

- Cox proportional hazard model for exposure
- Stratified analyses were performed by sex
- Sensitivity analyses by smoking status

Characteristics of the study population

	Men		Women	
n	17,772		24,327	
age [years] at t ₀ , mean (sd)	42.9 (13.1)		43.0 (13.5)	
BMI [kg/m ²] at t ₀ , mean (sd)	25.3 (3.17)		24.4 (4.05)	
18.5 – 24.9 kg/m ² , n (%)	8,895 (50.1%)		15,659 (64.4%)	
25.0 – 29.9 kg/m ² , n (%)	7,496 (42.2%)		6,365 (26.2%)	
30.0 – 35.0 kg/m ² , n (%)	1,381 (7.8%)		2,303 (9.5%)	
assessment interval [years], mean (sd)	t ₀₋₅ 5.2 (0.79)	t ₅₋₁₀ 4.9 (1.03)	t ₀₋₅ 5.2 (0.75)	t ₅₋₁₀ 4.9 (1.00)
Change of BMI [kg/m ² /year], mean (sd)	0.10 (0.31)	0.09 (0.34)	0.13 (0.39)	0.12 (0.41)
<-0.10 kg/m ² /year, n (%)	3,760 (21.2%)	4,025 (22.7%)	5,352 (22.0%)	5,621 (23.1%)
-0.10 – 0.09 kg/m ² /year, n (%)	5,527 (31.1%)	5,372 (30.2%)	6,635 (27.3%)	6,275 (25.8%)
≥0.10 kg/m ² /year, n (%)	8,485 (47.7%)	8,375 (47.1%)	12,340 (50.7%)	12,431 (51.1%)
Ever smoker, n (%)	7,835 (44.1%)		6,487 (26.7%)	
years of follow-up, median (Q1-Q3)	11.3 (8.1-13.4)		12.1 (9.1-13.7)	
number of deaths, n (%)	2,053 (11.6%)		2,066 (8.5%)	

Weight (BMI) change – prevalences

weight loss (< -0.10 kg/m²/year) 20%

stable weight (-0.10 to 0.09 kg/m²/year) 30%

(±2.6 kg in a person of 1.60 meters of height
±3.4 kg in a person of 1.85 meters over 10 years)

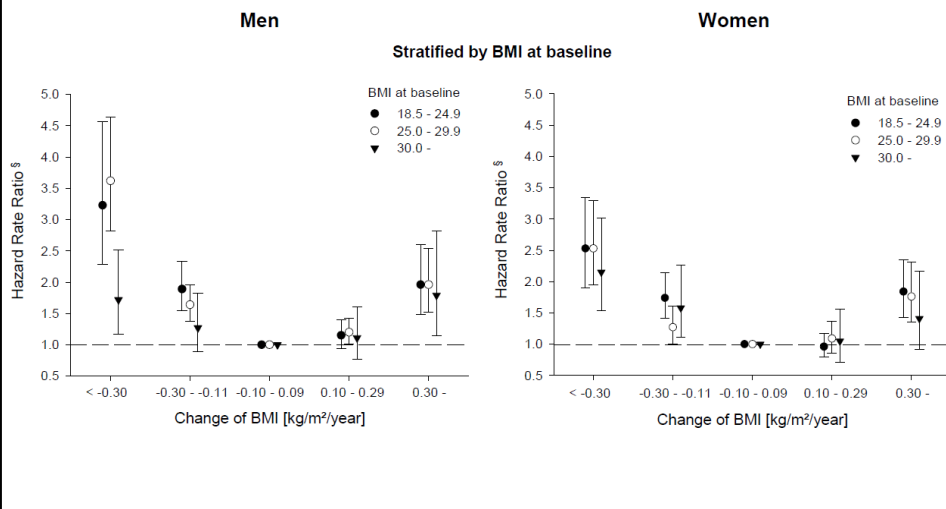
weight gain (≥ 0.10 kg/m²/year) 50%

(≥12.8 kg in a person of 1.60 meters of height or
≥17.1 kg in a person of 1.85 meters over 10 years)

Weight stability by BMI category

	Men	Women
Normal	11.3%	9.2%
Overweight	9.2%	6.0%
Obesity	5.4%	4.0%

BMI change by baseline BMI and sex



Effect of change of BMI between t_{0-5} and $t_{0-5} + t_{5-10}$ on all cause-mortality in men stratified for baseline BMI

Baseline BMI	Baseline			Pattern	t_{0-5}^*			Pattern	$t_{0-5}^* + t_{5-10}^*$		
	N (%)	Fatal events	HRR (95% CI) [§]		N (%)	Fatal events	HRR (95% CI) [§]		N (%)	Fatal events	HRR (95% CI) [§]
18.5 – 24.9 kg/m ²	8,895 (50.1)	757	1.00 [#]	-	1,329 (7.5)	170	1.14 (0.93; 1.39)	<	160 (0.9)	38	1.56 (1.05; 2.32)
								=	406 (2.3)	57	1.23 (0.87; 1.73)
								/	763 (4.3)	75	1.27 (0.93; 1.73)
								<	448 (2.5)	79	1.84 (1.35; 2.51)
								=	1,008 (5.7)	85	1.00 [#]
								/	1,438 (8.1)	86	0.95 (0.70; 1.28)
								<	1,159 (6.5)	139	1.58 (1.20; 2.08)
								=	1,534 (8.6)	100	1.11 (0.83; 1.48)
								/	1,979 (11.1)	98	1.14 (0.85; 1.53)
								<	320 (1.8)	63	1.88 (1.37; 2.59)
25.0 – 29.9 kg/m ²	7,496 (42.2)	1,039	1.13 (1.03; 1.24)	-	1,918 (10.8)	331	1.31 (1.11; 1.55)	<	483 (2.7)	63	1.32 (0.98; 1.79)
								=	1,115 (6.3)	165	1.47 (1.13; 1.92)
								/	521 (2.9)	103	1.75 (1.31; 2.35)
								<	687 (3.9)	93	1.15 (0.86; 1.55)
								=	2,335 (13.1)	340	1.17 (0.99; 1.39)
								/	1,127 (6.3)	144	1.26 (0.96; 1.65)
								<	984 (5.5)	156	1.66 (1.27; 2.17)
								=	3,243 (18.3)	368	1.18 (1.00; 1.39)
								/	946 (5.3)	93	1.09 (0.81; 1.46)
								<	1,313 (7.4)	119	1.27 (0.96; 1.68)
≥30.0 kg/m ²	1,381 (7.8)	257	1.50 (1.30; 1.73)	-	513 (2.9)	111	1.67 (1.33; 2.09)	<	129 (0.7)	34	1.96 (1.31; 2.96)
								=	104 (0.6)	28	2.08 (1.35; 3.19)
								/	280 (1.6)	49	1.80 (1.28; 2.57)
								<	93 (0.5)	26	2.12 (1.38; 3.30)
								=	298 (1.7)	59	1.50 (1.13; 2.00)
								/	131 (0.7)	22	1.60 (0.99; 2.56)
								<	74 (0.4)	11	1.32 (0.70; 2.48)
								=	570 (3.2)	87	1.63 (1.28; 2.09)
								/	211 (1.2)	41	2.34 (1.61; 3.40)
								<	130 (0.7)	23	1.64 (1.03; 2.61)
/	229 (1.3)	23	1.51 (0.95; 2.40)								

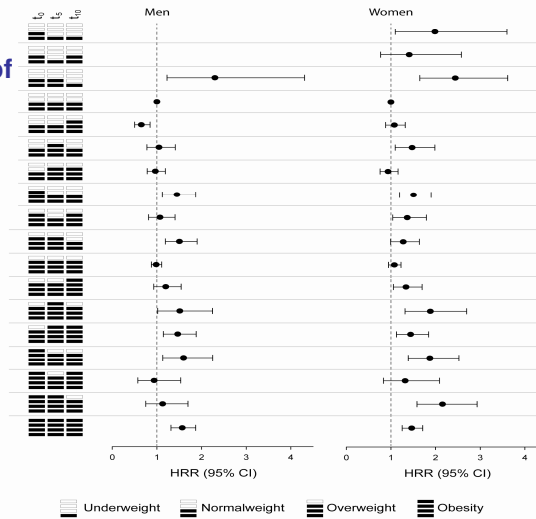
* change of BMI (<-0.10 kg/m²/year, -0.10 – 0.09 kg/m²/year, ≥0.10 kg/m²/year) between baseline and year 5 (t_{0-5}) and between year 5 and 10 (t_{5-10})
 § Hazard rate ratio (HRR) and 95% confidence interval (95% CI) adjusted for smoking status and stratified for age
 # reference category

Effect of change of BMI between t_{0-5} and $t_{0-5} + t_{5-10}$ on all cause-mortality in women stratified for baseline BMI

Baseline BMI	Baseline			Pattern	t_{0-5}^*			Pattern	$t_{0-5}^* + t_{5-10}^*$		
	N (%)	Fatal events	HRR (95% CI) [§]		N (%)	Fatal events	HRR (95% CI) [§]		N (%)	Fatal events	HRR (95% CI) [§]
18.5 – 24.9 kg/m ²	15,659 (64.4)	913	1.00 [#]	-	2,811 (11.6)	252	1.25 (1.05; 1.48)	<	331 (1.4)	65	2.54 (1.80; 3.59)
								=	725 (3.0)	67	1.60 (1.14; 2.25)
								/	1,755 (7.2)	120	1.34 (0.99; 1.80)
								<	793 (3.3)	88	1.78 (1.30; 2.45)
								=	4,614 (19.0)	284	1.00 [#]
								/	1,436 (5.9)	68	1.00
								<	2,385 (9.6)	128	1.22 (0.90; 1.63)
								=	2,049 (8.4)	134	1.47 (1.09; 1.97)
								/	2,304 (9.5)	113	1.21 (0.89; 1.63)
								<	3,881 (16.0)	130	1.06 (0.79; 1.42)
25.0 – 29.9 kg/m ²	6,365 (26.2)	806	1.17 (1.06; 1.29)	-	1,699 (7.0)	282	1.30 (1.10; 1.54)	<	343 (1.4)	67	2.14 (1.55; 2.95)
								=	335 (1.4)	54	1.42 (0.99; 2.04)
								/	1,021 (4.2)	141	1.58 (1.18; 2.12)
								<	393 (1.6)	70	1.56 (1.12; 2.19)
								=	1,586 (6.5)	209	1.11 (0.92; 1.33)
								/	808 (3.3)	86	1.39 (1.01; 1.92)
								<	385 (1.6)	53	1.31 (0.91; 1.88)
								=	3,080 (12.7)	315	1.24 (1.05; 1.45)
								/	954 (3.9)	137	1.88 (1.40; 2.52)
								<	675 (2.8)	59	1.25 (0.88; 1.78)
≥30.0 kg/m ²	2,303 (9.5)	347	1.52 (1.34; 1.72)	-	842 (3.5)	168	1.85 (1.52; 2.24)	<	1,451 (6.0)	119	1.49 (1.10; 2.01)
								=	247 (1.0)	74	3.13 (2.24; 4.37)
								/	137 (0.6)	32	2.37 (1.55; 3.62)
								<	458 (1.9)	62	1.85 (1.31; 2.61)
								=	1,586 (6.5)	209	1.11 (0.92; 1.33)
								/	139 (0.6)	31	2.34 (1.46; 3.64)
								<	139 (0.6)	31	2.34 (1.46; 3.64)
								=	435 (1.8)	70	1.38 (1.06; 1.80)
								/	204 (0.8)	27	1.85 (1.18; 2.89)
								<	372 (1.5)	49	1.94 (1.34; 2.81)
<	186 (0.8)	20	1.71 (1.03; 2.83)								
/	468 (1.9)	40	1.88 (1.12; 2.46)								

* change of BMI (<-0.10 kg/m²/year, -0.10 – 0.09 kg/m²/year, ≥0.10 kg/m²/year) between baseline and year 5 (t_{0-5}) and between year 5 and 10 (t_{5-10})
 § Hazard rate ratio (HRR) and 95% confidence interval (95% CI) adjusted for smoking status and stratified for age
 # reference category

Effect of different patterns of BMI at t_0 , t_5 , and t_{10} on all cause-mortality among men and women in the VHM&PP Study Cohort 1985-2009.



Discussion

- Observation on baseline BMI and mortality are consistent with results from other large cohort studies
- Observation between increasing weight loss and increased mortality is consistent with the literature.
- different approaches for assessing weight change (self-reported values, exposure time, definition of weight gain, e.g. ≥ 5 kg within 10 years)

Limitations

- Little information on potential confounders (socioeconomic status, comorbidity)
- No information on intention of weight loss
- Multiple Tests

Strengths

- Large, prospective study
- BMI change instead of weight change
- Repeated measurements by trained staff
- Long follow-up time (mean 12 years)

Summary

For men and women increase of BMI was the most common pattern (about 50%)

Weight loss is associated with increased all-cause mortality

Lowest mortalities in persons with normal weight or overweight at baseline and stable BMI over 10 years.

Conclusion

- obesity should be avoided
- weight stability within normal weight and overweight BMI ranges are an important public health prevention strategy

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Cumulative individual changes in anthropometric parameters over adult life by sex

