Associations of Overweight and Metabolic Health with Successful Aging: 32-Year Follow-up of the Helsinki Businessmen Study

Brief title. Overweight and successful aging

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Abstract

Background & Aims: Prognostic significance of metabolically healthy overweight and obesity (MHO) is under debate. However the relationship between MHO and health-related quality of life (HRQoL) is less studied. We compared successful aging (longevity plus HRQoL) in men with MHO, metabolically healthy normal weight (MHN) and metabolically unhealthy overweight and obesity (MUO).

Methods: In **t**he Helsinki Businessmen Study longitudinal cohort, consisting of men born 1919 to 1934. In 1985/86, overweight (BMI≥25 kg/m^2) and metabolic health were determined in 1309 men (median age 60 years). HRQoL was assessed using RAND-36/SF-36 in 2000 and 2007, and all-cause mortality retrieved from registers up to 2018.The proportion of men reaching 90 years was also calculated.

Results: Of the men, 469 (35.8%), 538 (41.1%), 276 (21.1%), and 26 (2.0%) were MHN, MHO, MUO and MUN, respectively. During the 32-year follow-up, 72.3% men died. With MHN as reference, adjusted hazard ratio with all-cause mortality was 1.08 (95% confidence interval [CI] 0.93 to 1.27) for MHO, and 1.18 (95% CI 0.95 to 1.47) for MUO. During follow-up, 273 men reached 90 years. With MHN as reference, adjusted odds ratio for MHO was 0.82 (95% CI 0.59 to 1.14) and 0.62 (95% CI 0.41 to 0.95) for MUO. Men in MHN group scored generally highest in RAND-36 HRQoL subscales in 2000 and 2007, of those significantly better in Physical functioning, Role physical, Role emotional, Bodily Pain, and General health sub-scales compared to MHO group in 2000.

Conclusions: As compared to MHN, MHO in late midlife does not increase mortality, but impairs odds for successful aging.

KEY WORDS. Quality of life, RAND-36, nonagenarians, successful aging, metabolically healthy overweight and obesity, metabolically unhealthy overweight and obesity

Highlights

- Metabolically unhealthy obesity (MHO) in late midlife did not increase mortality in this study.
- MHO impaired odds for successful aging defined as longevity and Health Related Quality of Life.
- Participants with metabolically healthy normal weight (MHN) at baseline had better HRQoL quality of life at old age compared to those with MHO or Metabolically unhealthy overweight (MUO) at baseline.
- Men with MHN had higher odds of reaching 90 years than those men with MHO or MUO at baseline.

ABBREVIATIONS. BMI=body mass index; CVD=cardiovascular disease; HRQoL=health-related quality of life; MetS=metabolic syndrome; MHN= metabolically healthy normal weight; MHO=metabolically healthy overweight and obesity; MUN= metabolically unhealthy normal weight; MUO= metabolically unhealthy overweight and obesity;

Introduction

Overweight and obesity are prevalent worldwide, and promote morbidity and mortality, especially from cardiovascular disease (CVD) (1). This is thought to be due to the associations of overweight and obesity with various CVD risk factors, including hypertension, dyslipidemia, hyperglycemia, and metabolic syndrome. However, not all overweight people have these risk factors and present therefore the phenotype of a metabolically healthy overweight (MHO) (2). Its prevalence varies considerably depending on the criteria used (3.3-32.1% in men), but it has been suggested that 9% to 16% of obese individuals are metabolically healthy (3, 4). Despite being a relatively common condition and after wide research activity, the clinical significance of MHO is still under debate (2, 5). It seems to be closely related to physical activity and cardiorespiratory fitness, and if these are taken into account, the prognosis of MHO may not be worse than that of individuals with metabolically healthy normal weight (MHN), at least according to short-term studies (6, 7). As age increases, MHO may turn into metabolically unhealthy overweight (MUO) (8), but to our knowledge there are no studies on whether MHO affects the probability of reaching very old age, over 90 years.

Moreover, longevity may not be desirable if quality of life is not maintained and the prolonged life span is not healthy. Weight gain up to midlife has been shown to sensitively affect health-related quality of life (HRQoL) in old age (more weight gain, worse HRQoL), but whether this applies to MHO is not known (9). Although there is no consensus regarding the definition of successful aging (10), longevity with preserved quality of life could define the concept in a simple way. The objective of the present analysis was to compare various combinations of body mass index (BMI) and metabolic health with HRQoL in a prospective long-term study, where a substantial proportion of participants reached 90 years of age.

Methods

Study population

Helsinki Businessmen Study (HBS) is a cohort of Finnish men, born 1919 to 1934, who have been followed-up since the 1960s in several waves and various constellations (11, 12). This male cohort is socioeconomically and ethnically homogenous and consequently some important confounders are intrinsically avoided. The follow-up study has been approved by the ethical committee of the Department of Medicine, Helsinki University Central Hospital and the study is registered with ClinicalTrials.gov identifier: NCT02526082.

In HBS, participants' CVD risk factor history is known since midlife (13). In the present analysis we focused on a representative sample of men in this cohort who were clinically healthy in 1974 and who responded to a health survey and underwent laboratory examinations in 1985/86, when their median age was 60 years (n=1399). Although part of the cohort participated in a prevention trial during the 1970s (14), that did not affect the results of the present long-term analyses and all men were included. The flow chart of the study is shown in **figure 1**.

Metabolic status

At baseline examination, serum lipids, fasting blood glucose levels, blood pressure and waist circumference were measured as described earlier, and questionnaires were used to define health, lifestyle, and background characteristics (15). Using data from these examinations, we determined the presence of metabolic syndrome (MetS) according to the International Diabetes Federation definition (**Table 1**) in 1309 participants (93.4%) (16).We used the definition used in the MESA (16) in order to ease comparisons with American studies.

However, using a definition with waist circumference $\geq$ 94 cm plus at least 2 other factors of MetS did not change the general conclusions in the present study.

In the 1309 participants, the prevalence of normal weigh (BMI < 25 kg/m^2), overweight (BMI 25-29 kg/m^2), and obesity (BMI $\geq$30 kg/m^2) were 38.3% (n=501), 52.3% (n=684), and 9.5% (n=124), respectively. Because of the relatively low number of obese men in this older cohort, we defined the metabolic status groups according to normal weight vs overweight plus obesity (**Table 2**). Metabolically Healthy Normal weight (MHN), Metabolically Unhealthy Normal weight (MUN), Metabolically Healthy Overweight (MHO) and Metabolically Unhealthy Overweight (MUO) phenotype groups comprised 469 (35.8%), 26 (2.0%), 538 (41.1%), and 276 (21.1%) men, respectively.

Because laboratory indicators of metabolic health were not available in 2000 or 2007, we used both information on prescribed medication for hypertension and diabetes up to 2007, and self-reported data of these conditions in the questionnaires. Both diabetes and antihypertensive medication are reimbursed by the Finnish Social Security Office, which keeps statistics of prescribed medications in Finland. We used the personal identification number (unique for all Finnish residents) to retrieve information for our cohort from the Social Security Office registers. Reimbursement requires the fulfilment of strict diagnostic criteria, but because cheap medications may be used without reimbursement, we considered it important to combine register data with self-report of hypertension and diabetes.

At baseline and in 2000 and 2007, physical activity was assessed with the questions: "Do you exercise regularly weekly, yes/no" and if yes "How many hours weekly?" In 2000, men were also asked how many hours they exercised heavily causing breathlessness/sweating.

Health related quality of life

The RAND-36 HRQoL instrument (practically identical to Short Form [SF]-36) was used to assess HRQoL (17), and it has been validated in Finnish population (18). RAND-36 consists of 8 subscales: Physical function, Role limitations caused by physical health problems, Role limitations caused by emotional problems, Vitality, Mental health, Social functioning, Bodily pain, and General health (17). In the HBS cohort, HRQoL using RAND-36 has been assessed regularly since 2000; for the present analyses we used data of from mailed questionnaire waves in 2000 (mean age of respondents 73 years), and 2007 (mean age 80 years). We calculated the 8 subscales using standard procedures and used them separately in the analyses (17, 18).

All-cause mortality

The number of survivors in the cohort was updated through March 15, 2018 from the Population Information System of Finland, and total mortality and proportion of men reaching 90 years was calculated.

Statistical analysis

Descriptive statistics, Armitage test for trend in proportions, and analysis of covariance (ANCOVA, Bonferroni test for multiple comparisons) were used to compare the metabolic status groups. Because men with MUN at baseline only included 26 men we excluded them from HRQoL and mortality analyses. Because men with MetS as defined ($\geq$ 3 components out of 5) may still have factors affecting HRQoL, the ANCOVA analyses of HRQoL in 2000 and 2007 were conservatively adjusted for age, baseline systolic blood pressure, triglycerides, and smoking. Also the association of weekly exercise at baseline or during follow-up was tested. As sensitivity analyses we assessed the association of baseline overweight without all MetS components (except waist circumference) with HRQoL in 2000. Cumulative mortality up to

March 15, 2018 in MHN, MHO, and MUO groups were compared using Kaplan-Meier curves and log-rank testing. Mortality in the groups was further compared using Cox's regression analysis (after ensuring the proportional hazards assumption), and hazard ratios (HR) with 95% confidence intervals (CI) were calculated. Logistic regression was used to compare metabolic groups in reaching 90 years of age. Statistical analyses were performed using NCSS statistical software (Kaysville, UT, www.ncss.com, version 8).

Results

Of the participating men, 37%, 41%, 20% and 2% were MHN, MHO, MUO and MUN, respectively in 2000.

The prevalence of hypertension and diabetes (self-report and drug reimbursement data combined) up to 2007 was used to reflect metabolic health during follow-up. Baseline characteristics, and BMI, smoking, exercise, and alcohol consumption during follow-up in all metabolic groups are shown in **Table 2**. The differences in BMI between metabolic status groups remained during the 21-year follow-up, but there was a significant decrease of BMI inside the groups among those who survived to 2007. In MHN, BMIs were 23.4 (SE 0.1), 23.5 (0.1), and 23.1 (0.1) in 1985/86, 2000, and 2007, respectively (P=0.01). In MHO, 26.9 (0.1), 26.9 (0.1), and 26.2 (0.1), respectively (P<0.001). In MUO, 29.0 (0.3), 28.3 (0.3), and 27.3 (0.3), respectively (P<0.001). In MUN, 24.1 (0.3), 23.9 (0.3), and 22.9 (0.3), respectively (P=0.12)

At baseline, compared to MHN group, MHO group tended to have higher blood pressure, serum triglycerides and lower HDL-cholesterol, whereas blood glucose and LDL-cholesterol were comparable. Alcohol consumption was higher and history of smoking more prevalent among the MHO group as compared to the men with MHN. In MUO, all risk factors and

lifestyle variables were less favorable as compared to those associated with MHN and MHO. The proportion of men reporting no exercise decreased in the order MHN, MHO and MUO, whereas weekly time of exercise among active men was similar between the groups.

Except for BMI, the characteristics in MUN largely compared to those in MUO, but because of few men included, MUN was excluded from further analyses.

Hypertension was present in 46.1%, 46.2%, and 68.6% of the MHN, MHO, and MUO men, respectively ($p < 0.001$ between groups); diabetes in 6.4%, 8.7% and 28.3% of the MHN, MHO, and MUO men, respectively ($p < 0.001$ between groups). While both conditions (hypertension, diabetes) were less prevalent according to drug reimbursement, the differences between the metabolic groups were similar (data not shown).

The HRQoL data in the metabolic groups in 2000 and 2007 are shown in **Table 3**. To control for baseline factors potentially affecting HRQoL, the RAND-36 subscales were adjusted for age, baseline systolic blood pressure, log triglycerides, and smoking. Overall, the average scores of all subscales, especially physical ones, were highest in MHN, whereas the scores were more comparable between MHO and MUO. We also tested adjustment for physical activity at baseline or during follow-up, but it did not materially change the results.

During the 32-year follow-up, 947 (72.3%) men died; cumulative mortality curves are shown in **Figure 2**. MUO had highest crude mortality (79.7%), while mortality was quite similar between MHO (70.6%), and MHN (69.2%). The proportions of men reaching 90 years were 15.6%, 19.1%, and 25.6% in MUO, MHO, and MHN, respectively. Adjusted risks for mortality and odds of reaching 90 years are shown in **Table 4**. While long-term mortality risk in MUO was significantly higher than in MHN or MHO when adjusted for age alone, differences disappeared when further adjusted for baseline smoking, systolic blood pressure

and log triglycerides. In contrast, MUO men had, and MHO tended to have lower odds of reaching 90 years of age after full adjustments.

Discussion

While adjusted cumulative 32-year all-cause mortality was similar among men with MHO and MHN, MHO was associated with lesser odds of reaching 90 years of age than MHN. Also, physical components of quality of life were consistently worse at 73 years and 80 years among men with MHO at the baseline as compared to MHN. These results suggest that at least in men, who have survived to late midlife, MHO is not a "healthy" condition in older age and reduces odds for successful aging. In general, our results highlight and suggest an important difference: survival prognosis is driven by metabolic health, but odds for successful aging are driven by overweight/obesity in midlife. In other words, longer life may nevertheless be of poorer quality.

The overall evidence concerning the association between metabolically healthy overweight/obesity and CVD has been described as "broad and mixed" (16), Our results support those who have been critical of the concept (4) by demonstrating that even already metabolically healthy overweight, not only obesity, is related to less successful aging. One of the explanations for conserved metabolic health despite obesity has been more physical activity and good cardiorespiratory fitness which counteract metabolic disturbances (6, 19). There were more men without regular reported exercise in the MHO group as compared to the MHN group, but differences were not large, mortality was similar, and HRQoL differences remained after adjustment for physical activity. On the other hand, MHO may also turn into MUO when people age (5). A recent study showed that MHO is not a stable state and during the 12.2-year follow-up, half of those with MHO phenotype progressed to MetS and increased

their risk of CVD events (5, 18)). Similarly, a recent study from the Nurses' Health study reported that even when metabolic health is maintained during long periods of time, obesity remains a risk factor for CVD (20). In a recent study individuals with MHO had a higher risk of coronary heart disease, cerebrovascular disease, and heart failure as those with MHN (21). In our cohort MHO was associated with slightly more diabetes, but not hypertension, than men with MHN during follow-up. In contrast, men with MUO at baseline developed clearly more diabetes and hypertension up to 2007.

In aging societies, successful and functional aging is an increasingly important goal, but so far data on long-term predictors of successful aging have been relatively scarce. A recent longitudinal study of the Whitehall cohort reported findings similar to our study: Those who had MHO at baseline had a 2- fold higher decline in physical functioning over the course of 20 years, and a 6-fold higher worsening of bodily pain compared to MHN individuals (22). Similarly, although not categorized according to metabolic health, excess BMI was associated with substantially shorter healthy and chronic disease-free life expectancy between ages 50 to 75 years, consequently linking normal BMI to successful aging (23).

Strengths and limitations

The strengths of our study include the extended follow-up, excellent to good participation even in the last survey in 2007, and reliable retrieval of data from national registers. Furthermore, we used the widely accepted definition of metabolic status by the International Diabetes Federation definition (16), which makes the comparison to other studies feasible. Main limitation is that the cohort of male survivors in a long-term observational study is obviously selected. The participants were surviving Caucasian men from the highest socio-economic group, and their health and characteristics probably differ from those of the general

population, for example, the prevalence of obesity was low in this cohort born in the years 1919-1934. The results cannot thus be directly applied to other populations. However, the homogeneous cohort is also a strength through reducing confounding, which may be important in a study related to lifestyle. The physical activity was self-reported, though we did not measure physical fitness, which is clearly a limitation of this study as two recent papers state the importance of measured physical fitness (24, 25). Although we adjusted for self-reported physical activity, it could be over- or underestimated by the participants. Moreover, our study sample was not very large, but the long follow-up time (32 years) combined with the robust results between the metabolic status and quality of life, enhance the significance of this study.

Conclusions

All-cause mortality during a very long follow-up (32 years) to old age was not affected by metabolically healthy overweight/obesity as compared to metabolically healthy normal weight in late midlife (mean 60 years) in our study. However, overweight-- even metabolically healthy -- tended to impair odds for successful aging.

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LEGENDS TO THE FIGURES

Figure 1. Flow chart of the study

Figure 2. Cumulative total mortality during 32-year follow-up

Groups (defined in Table 1) are metabolically healthy normal weight (MHN, solid line), metabolically healthy overweight (MHO, dots), and metabolically unhealthy overweight (MUO, solid-dot line).

386 Table 1. Definitions of Metabolic Syndrome and Metabolically Healthy Overweight/obesity

Metabolic status groups	
Metabolically healthy normal weight (MHN)	BMI < 25 kg/m^2, not MetS
Metabolically healthy overweight and obesity (MHO)	BMI ≥ 25 kg/m^2, not MetS
Metabolically unhealthy normal weight (MUN)	BMI < 25 kg/m^2 with MetS
Metabolically unhealthy overweight and obesity (MUO)	BMI ≥ 25 kg/m^2 with MetS
Harmonized International Diabetes Federation criteria for MetS: ≥ 3 of the following components *	
Triglycerides ≥ 1.69 mmol/L (150 mg/dL)	
HDL cholesterol < 1.04 mmol/L (40 mg/dL)	
Systolic blood pressure ≥ 130 mm Hg, or diastolic blood pressure ≥ 85 mm Hg, or diagnosis of hypertension	
Fasting glucose ≥ 5.55 (100 mg/dL), or diagnosis of diabetes	
Waist circumference (men) > 102 cm	

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388 MetS=metabolic syndrome.

389 * Reference # 16

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392 Table 2. Age-adjusted clinical characteristics of study population (n=1309)

Variable in 1985/86	MHN, n= 469	MHO, n=538	MUN, n=26	MUO, n=276	*p* Value
Age, yrs, median (interquartile range)	60 (57-64)	59 (56-63)	60 (57-64)	60 (56-63)	0.032
BMI at 25 years, kg/m^2	21.9 (0.1)	23.2 (0.1)	22.1 (0.4)	23.2 (0.1)	<0.001
BMI, kg/m^2	23.2 (0.09)	27.1 (0.08)	23.8 (0.4)	29.0 (0.1)	<0.001
Weight gain from 25 years, kg	4.1 (0.3)	12.3 (0.3)	5.4 (1.5)	18.2 (0.4)	<0.001
Waist circumference, cm	89.6 (0.3)	98.4 (0.3)	92.7 (1.3)	105.7 (0.4)	<0.001
Alcohol, g/week	99.6 (6.4)	118.0 (5.9)	116.8 (26.9)	150.1 (8.3)	<0.001
Smoking history, n (%)	245 (52.2)	324 (60.2)	19 (73.1)	196 (71.0)	<0.001
No regular exercise, n (%)	82 (17.5)	114 (21.2)	6 (23.1)	93 (34.4)	<0.001

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Table 2 Continued

Exercise hours among active, median (IQ range)	4 (2-6)	4 (2-6)	4 (2-7)	4 (2-6)	0.57
Systolic BP, mm Hg	136.0 (0.8)	139.8 (0.7)	147.0 (3.2)	145.7 (1.0)	<0.001
Diastolic BP, mm Hg	84.8 (0.4)	88.4 (0.4)	90.2 (1.8)	91.1 (0.6)	<0.001
Fasting blood glucose	4.68 (0.05)	4.73 (0.05)	5.62 (0.22)	5.65 (0.07)	<0.001
Cholesterol, mmol/L	6.4 (0.1)	6.4 (0.05)	6.3 (0.2)	6.6 (0.1)	0.09
HDL cholesterol, mmol/L	1.52 (0.02)	1.41 (0.02)	1.02 (0.07)	1.16 80.02)	<0.001
LDL cholesterol, mmol/L	4.4 (0.05)	4.5 (0.05)	4.4 (0.2)	4.4 (0.07)	0.57
Triglycerides, mmol/L	1.16 (0.04)	1.31 (0.03)	2.11 (0.15)	2.38 80.05)	<0.001

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Table 2 Continued

Variable in 2000	n=361	n=401	n=19	n=196	
BMI, kg/m^2	23.4 (0.1)	26.7 (0.1)	23.4 (0.6)	27.9 (0.2)	<0.001
Alcohol, g/week	103.4 (7.3)	126.0 (7.0)	89.6 (31.4)	136.3 (10.1)	0.025
Present smokers, (%)	30 (8.3)	16 (4.0)	2 (11.1)	14 (7.1)	
No regular exercise, n (%)	48 (13.3)	74 (18.5)	2 (10.5)	46 (23.5)	0.017
Exercise hours among active, median (IQ range)	5 (3-8)	5 (3-9)	4 (2-6)	5 (3-8)	0.15
Variable in 2007	n=245	n=247	n=12	n=127	
BMI, kg/m^2	23.1 (0.2)	26.2 (0.2)	22.9 (0.7)	27.3 (0.2)	<0.001
Alcohol, g/week	86.2 (7.1)	104.0 (7.1)	77.1. (32.0)	100.3 (9.8)	0.30
Present smokers, n (%)	9 (3.7)	8 (3.3)	1 (8.3)	3 (2.4)	0.71
No regular exercise, n (%)	34 (13.9)	45 (18.2)	2 (16.7)	25 (19.7)	0.37
Exercise hours among active, median (IQ range)	5 (3-7)	5 (3-8)	4 (2-7)	5 (2-8)	0.65

395 Values are means (SE) for continuous variables.

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397

398 Table 3. Health-Related Quality of Life in 2000 and 2007 adjusted for age, systolic
399 bloodpressure, log triglycerides and smoking at baseline in 1985/86

RAND-36 subscale * in 2000	MHN, n= 361	MHO, n=401	MUO, n=196	*p* Value †
Physical functioning	81.6 (1.2)	76.3 (1.1)**	75.7 (1.6)**	0.003
Role physical	76.4 (2.1)	66.0 (1.9)**	62.1 (2.7)**	0.001
Role emotional	83.1 (1.9)	73.2 (1.8)**	73.1 (2.6)**	<0.001
Vitality	70.2 (1.2)	68.4 (1.1)	67.0 (1.5)	0.32
Mental health	83.2 (1.0)	80.7 (0.9)	80.4 (1.3)	0.13
Social functioning	86.9 (1.2)	84.8 (1.1)	83.4 (1.6)	0.28
Bodily pain	81.6 (1.2)	76.3 (1.2)**	77.9 (1.7)	0.008
General health	62.1 (1.0)	58.2 (1.0)**	59.5 (1.4)	0.021

400

401

Table 3 Continued

RAND-36 subscale * in 2007	MHN, n= 245	MHO, n=247	MUO, n=127	*p* Value †
Physical functioning	76.8 (1.5)	73.4 (1.5)	68.9 (2.1)**	0.037
Role physical	75.8 (2.6)	66.8 (2.5)**	55.5 (3.5)**	0.0005
Role emotional	83.6 (2.3)	77.7 (2.3)	66.4 (3.2)**	0.0015
Vitality	71.9 (1.2)	69.6 (1.2)	68.1 (1.7)	0.27
Mental health	82.6 (1.0)	80.1 (1.0)	80.4 (1.4)	0.21
Social functioning	86.4 (1.2)	83.1 (1.2)	81.0 (1.6)**	0.046
Bodily pain	81.7 (1.4)	79.3 (1.4)	74.1 (2.0)**	0.037
General health	61.7 (1.1)	59.5 (1.6)	56.2 (1.6)**	0.065

Variables are mean (SE).
*Score in subscales between 0 (worst) and 100 (best) points.
† Analysis of covariance (ANCOVA).
** Significantly different from MHN (Bonferroni test for multiple comparisons).

Table 4. Multivariate-Adjusted Hazard Ratios of Total Mortality and Odds Ratios of Reaching 90 Years of Age During the 32-Year Follow- up of the Helsinki Businessmen Study

	HR (95% CI) of total mortality during 32-year follow-up *		
	MHN	MHO	MUO
Model A†	1.0	1.17 (1.01-1.36)	1.53 (1.29-1.82)
Model B‡	1.0	1.08 (0.93-1.27)	1.18 (0.95-1.47)
	OR (95% CI) of reaching 90 years of age §		
Model A†	1.0	0.78 (0.57-1.06)	0.59 (0.39-0.87)
Model B‡	1.0 (1.05-2.46)	0.82 (0.59-1.14)	0.62 (0.41-0.95)

*HR was calculated using the Cox regression analysis with MHN as reference (HR = 1.0). †Model A: adjusted for age at baseline in 1985/86. ‡Model B: adjusted for age, systolic blood pressure, log triglycerides, and smoking at baseline. § OR was calculated using logistic regression with MHN as reference (OR=1.0).

HR = hazard ratio; OR = odds ratio; CI=confidence interval

Figure 1.

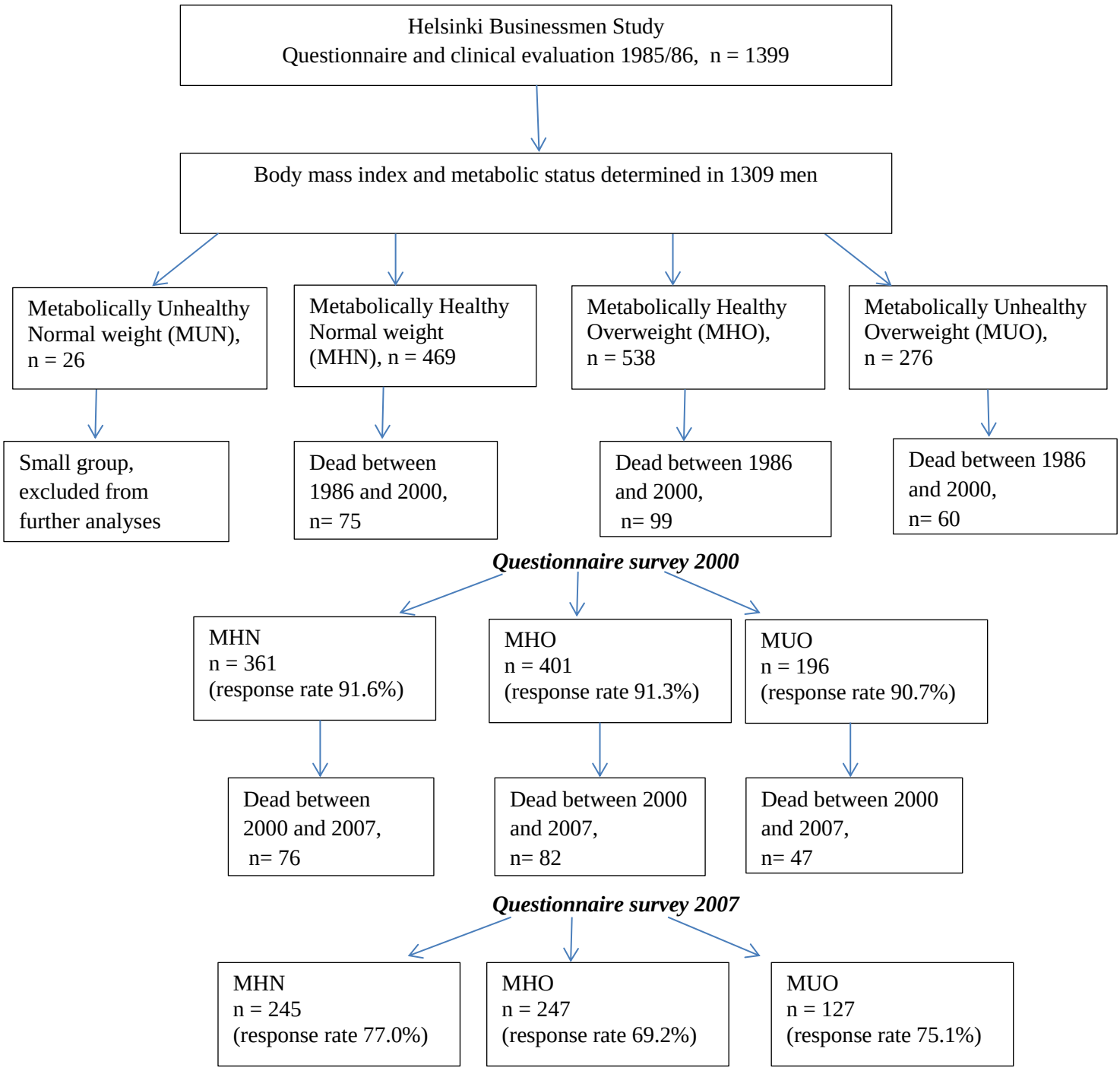
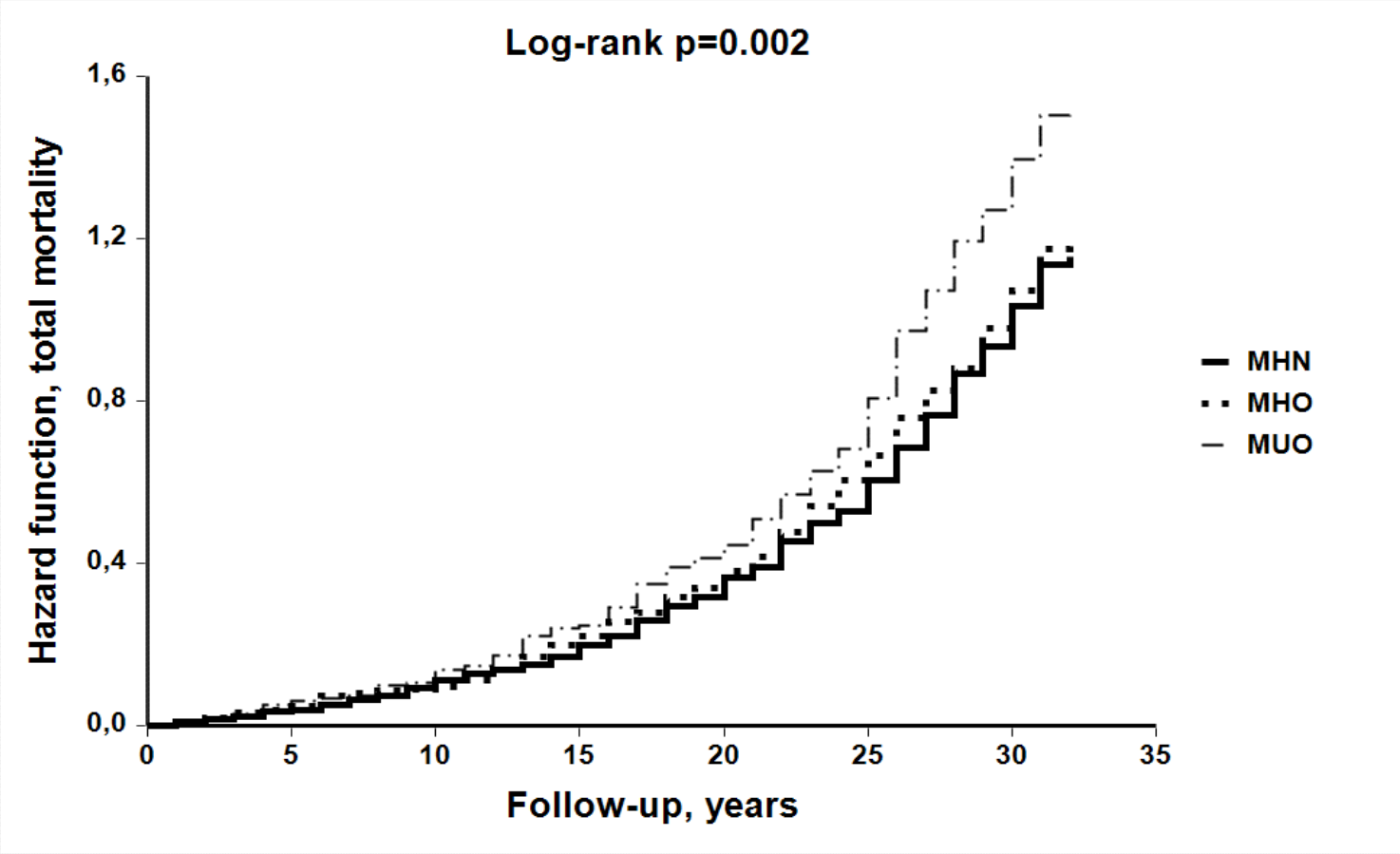

Helsinki Businessmen Study
Questionnaire and clinical evaluation 1985/86, n = 1399
Body mass index and metabolic status determined in 1309 men
Metabolically Unhealthy Normal weight (MUN), n = 26
Metabolically Healthy Normal weight (MHN), n = 469
Metabolically Healthy Overweight (MHO), n = 538
Metabolically Unhealthy Overweight (MUO), n = 276
Small group, excluded from further analyses
Dead between 1986 and 2000, n= 75
Dead between 1986 and 2000, n= 99
Dead between 1986 and 2000, n= 60
Questionnaire survey 2000
MHN n = 361 (response rate 91.6%)
MHO n = 401 (response rate 91.3%)
MUO n = 196 (response rate 90.7%)
Dead between 2000 and 2007, n= 76
Dead between 2000 and 2007, n= 82
Dead between 2000 and 2007, n= 47
Questionnaire survey 2007
MHN n = 245 (response rate 77.0%)
MHO n = 247 (response rate 69.2%)
MUO n = 127 (response rate 75.1%)

Figure 2


Log-rank p=0.002
Hazard function, total mortality
1,6
1,2
0,8
0,4
0,0
0
5
10
15
20
25
30
35
Follow-up, years
MHN
MHO
MUO