New approaches in differential mortality research

Johannes Klotz

Brussels, 26 October 2018

The current situation

Mortality research

- Socio-economic disparities
- Relationship between mortality and morbidity (expansion vs. compression of morbidity)
- Variation in individual lifespans
- Mortality developments among the oldest-old (mortality plateau)
- Small-area mortality (Glasgow effect)
- Slowdown of life expectancy increases since ~2010

Methodological developments

- Stochastic variation in mortality rates
- Model-assisted estimation, multivariate Models
- Estimation based on sample survey data
- Period vs. cohort mortality
- Mortality projections

National statistical institute

- Massive amount of data, limited capacities to analyze
- Registers and administrative records, linked datasets
- Longitudinal data
- Harmonization across sample surveys
- Publication by topic rather than data source

Two examples of “new” analyses

Example I

- Mortality of the absolutely poor
- European coverage
- People in private households aged 35-79 yrs
- Harmonized sample survey longitudinal data
- Vital status information in discrete time (is the person eligible for re-interviewing?)

Example II

- Mortality determinants at advanced ages
- Austrian coverage
- Men aged 80-99 years
- Register-based census data enriched with tax records and social security records (deterministic linkage)
- Vital status information obtained from national mortality register (deterministic linkage)

Similarities

- Mortality by socio-economic status
- Follow-up data, baseline measurement of covariates
- Individual variation in follow-up times
- Estimation of relative mortality risks
- Proportional Hazards Regression (Cox 1972)
- Implementation in SAS

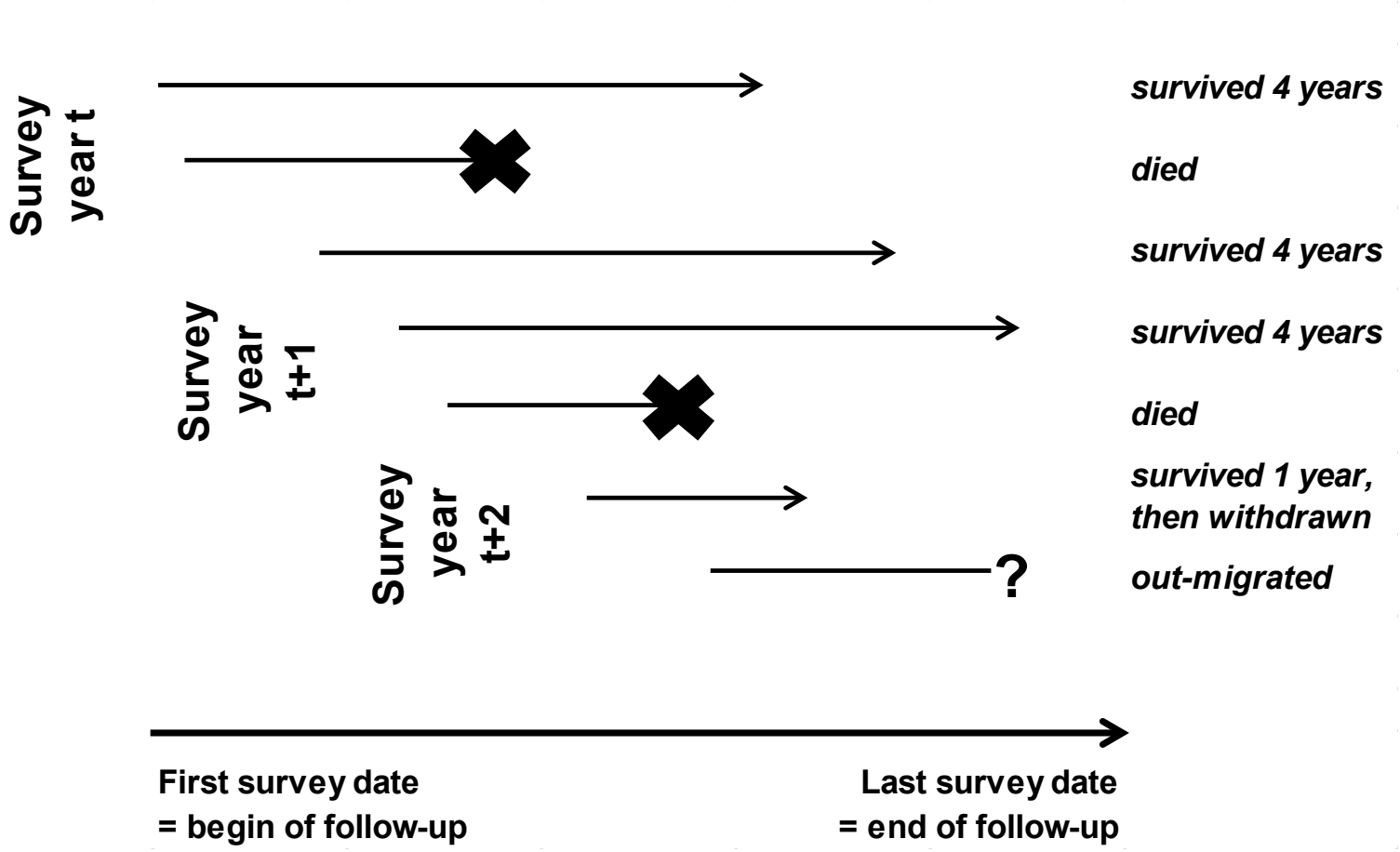
Example I

Relationships between morbidity, mortality, and severe material deprivation in Europe

EU-SILC

- Annual sample survey
- Carried out since 2003
- Implemented in all EU + some more countries
- People living in private households
- More than 200 variables
- Longitudinal component: measurement of vital status (survived or died since last wave)
- Eurostat User Database (UDB) data

Longitudinal sample survey data



The FACTAGE method

- Assess vital status information of EU-SILC respondents from intrinsic longitudinal data
- Individual follow-up usually 3 years, except
  - in countries with different than 4-wave panel
  - for respondents first interviewed only recently
  - for respondents who discontinued responding before completing the whole panel
- Measurement of analytical variables and covariates at baseline (first interview)

Severe material deprivation

- A person lives in a private household which **cannot afford** at least 4 items out of the following 9:
  - to pay their rent, mortgage or utility bills
  - to keep their home adequately warm
  - to face unexpected expenses
  - to eat meat or proteins regularly
  - to go on holiday
  - a television set
  - a washing machine
  - a car
  - a telephone

Severe material deprivation

- Severe material deprivation (SMD) has the same definition across all European countries and over time; it does not depend on the average standard of living in a society
- SMD is not a matter of choice
- Broad political consensus that SMD should be eliminated or at least reduced
- Prevalence of SMD in Europe in 2016: less than 1 percent in Sweden, more than 30 percent in Bulgaria

Research questions

1. Is there a substantial and statistically significant association between SMD and mortality risk?
2. Is this association still substantial and statistically significant when we adjust for different morbidity levels between SMD and non-SMD populations? (confounding, reverse causation)
3. Is there variation in the adjusted mortality effect between
    a. men and women?
    b. Western and Eastern Europe? (effect modification)

Data source

- EU-SILC User Database longitudinal data for 26 countries
- Observations from 2003 (earliest) to 2015; in most countries a person is traced over four years
- Annual vital status information (survived or died); measurement of covariates at baseline
- 743,000 individuals aged 35-79 years; 1.76m person years lived; 14,066 deaths
- Weighting of countries according to population size, uniform weights within each country and sex

Statistical model

- Proportional Hazards Regression (Cox 1972): Nonlinear, semiparametric model of mortality hazard of i'th individual as a function of follow-up time t and covariates x

$$h(i,t) = h(t) \times HR(i)$$
$$HR(i) = \exp(x_i^T \beta)$$

- Hazard Ratio when SMD = 1 as indicator of excess mortality
- Covariates: Age, Sex, Country, Period, (GALI)

Hazard ratios

	Model I	Model II
Age	1.10 ***	1.08 ***
Sex (Male = 1)	1.90 ***	1.98 ***
Calendar year	0.96 ***	0.96 ***
SMD = 1	**1.69 *** **	**1.39 *** **
GALI	NI	0.47 ***

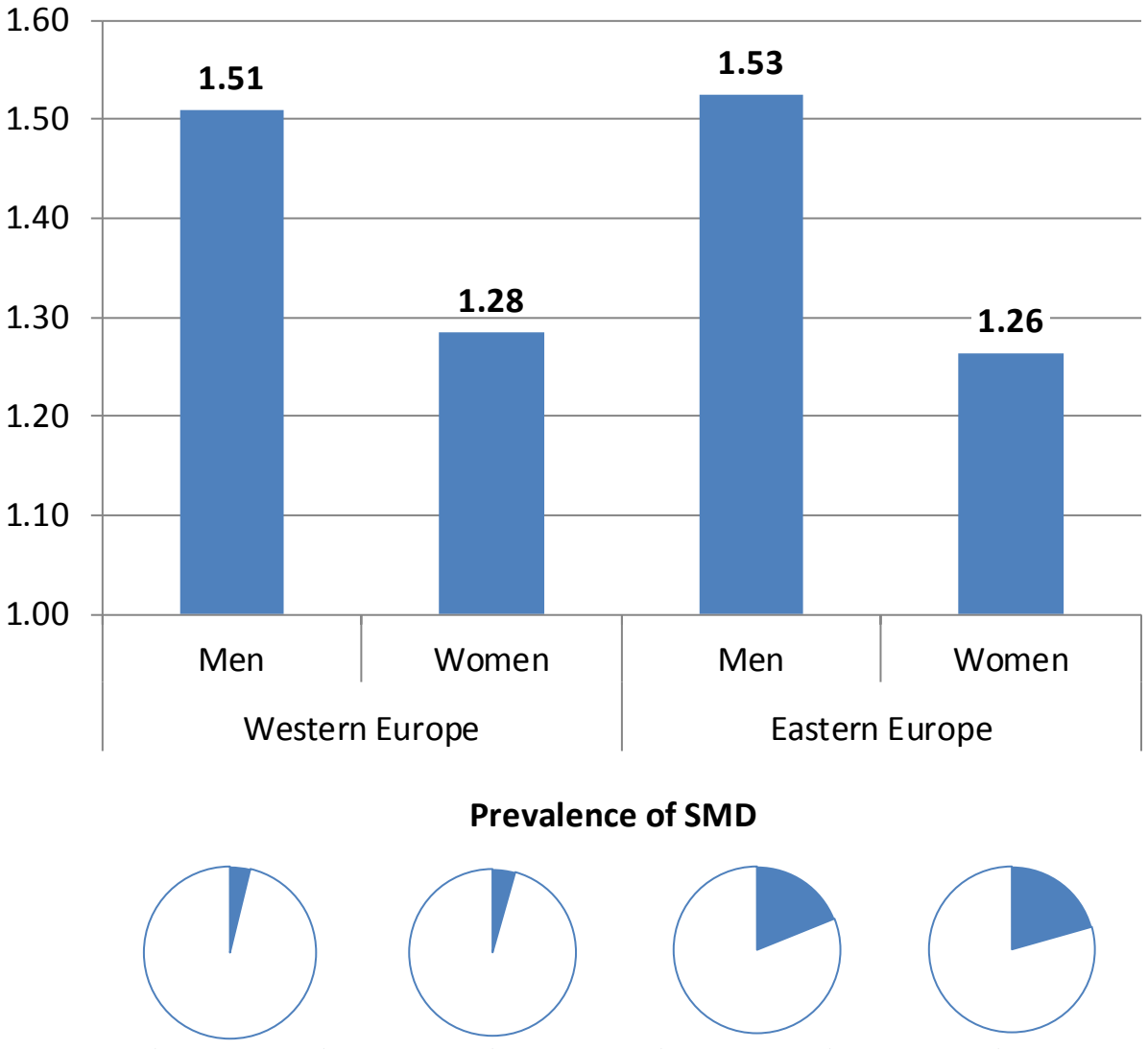
*** $p < 0.001$

All estimates are controlled for country fixed effects.

Findings

1. Mortality risk is substantially higher when severely materially deprived. Hazard ratio is 1.69, so in terms of mortality risk, the deprived are 5-6 years “older” than the non-deprived of same chronological age.
2. Around 40 percent of excess mortality is mediated by higher morbidity levels in the SMD population (Baron and Kenny 1986). When adjusting for GALI, excess mortality of the deprived is 1.39.

Hazard ratios



Findings

3.a. Excess mortality of the deprived is significantly higher among men than women—although the prevalence of severe material deprivation is almost identical between the sexes (household definition)

3.b Excess mortality of the deprived is almost identical in Western and in Eastern Europe—although the prevalence of SMD is five times as high in Eastern Europe

Outlook

Forthcoming paper:

J. Klotz, T. Göllner and M. Till (2018): “Relationships between morbidity, mortality and severe material deprivation in Europe”

Example II

Too rich to die young? Mortality determinants among oldest-old Austrian men

Scarce evidence at old ages

- Although the contribution of older ages to socio-economic inequalities in mortality is ever rising, relatively little is known about the elderly
- Demographic theory suggests reduction of hazard ratios due to selective survival
- Problems with reliability and validity in traditional data sources

Measurement problems

- Sample survey longitudinal data
  - too few respondents at old ages, especially men
  - non-coverage of the institutionalized population
  - health-related nonresponse
- Census linkage with mortality records
  - Income is often not available in censuses
  - Occupational class not available; former occupational class unimportant at old ages
  - Education not as distinctive in older cohorts
  - Proxy interviews by staff in institutions

Enriched register-based census

- In Austria in 2001 last traditional paper and pencil census
- Transformation to register-based census
- Linkage of other data via unique identifier
- Statistical data processing (e.g. household characteristics)

Technical follow-up

- Men aged 80-99 years living in Austria on 31 October 2011 (date of register-based census)
- Variables from register-based census enriched with social security and tax records
- Deterministic linkage with national mortality register in November 2011 - October 2016
- Has this man…
  - survived?
  - died?
  - emigrated from Austria? (few cases)

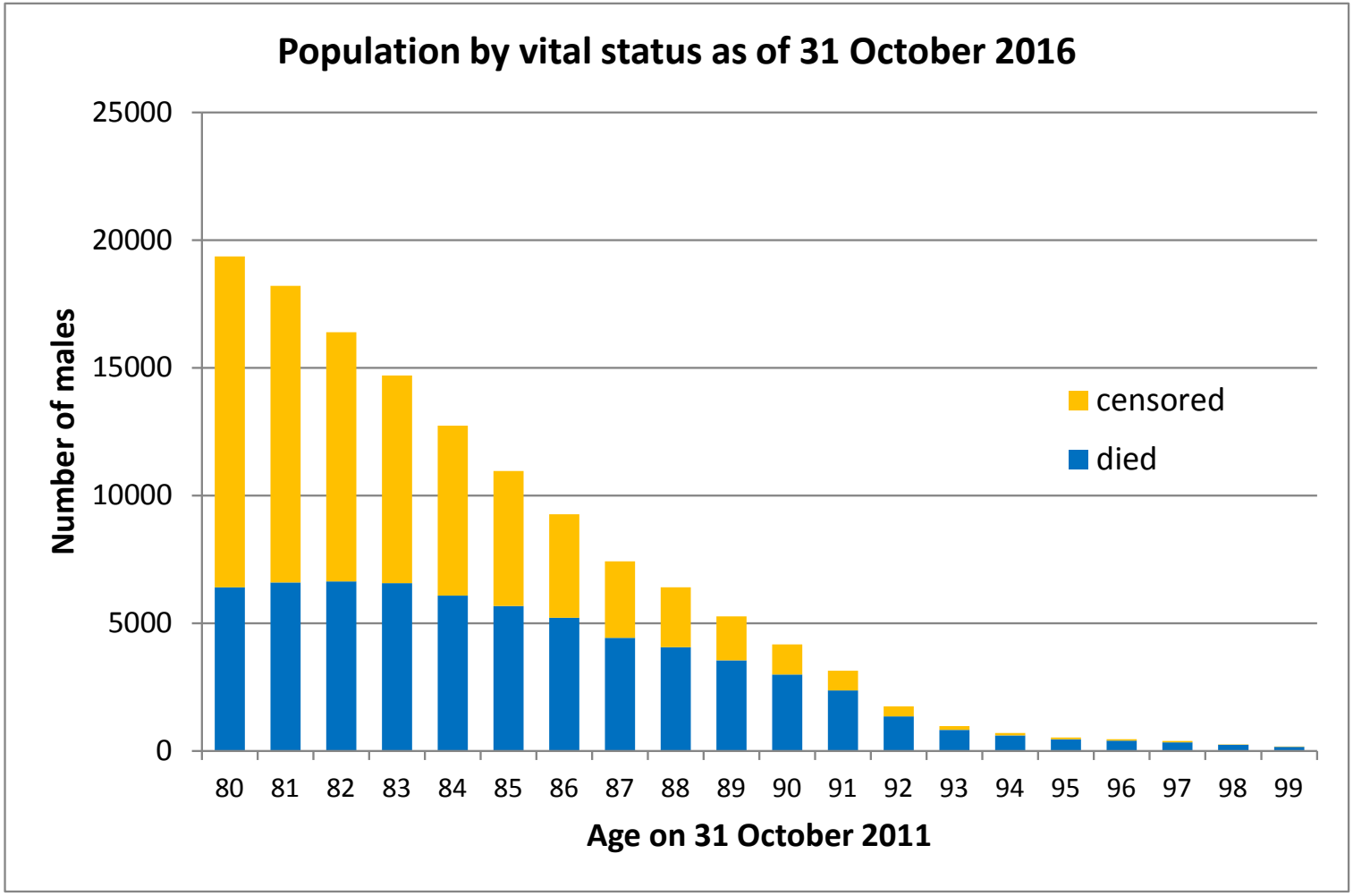
Technical follow-up

- 136,052 men were ‘counted’ on 31 October 2011
- 29 late notifications of deaths before 31 October 2011
- For 43 cases neither survival nor death nor emigration can be verified
- In 2,747 cases no information from tax records
  - no (Austrian) pension
  - missing ID variable in tax records
- **133,243 men (98 percent) linkable with tax records and verified vital status as of 31 October 2016**

Baseline variables

- Register-based census
  - Age in completed years
  - Household type (single, multi-person, institution)
  - Highest educational level completed
- Tax records
  - Annual gross income in ‘000 euros
  - Type of pension (social security, civil servant’s, other)
- Social security records
  - Standardized level of care (if social security pension)

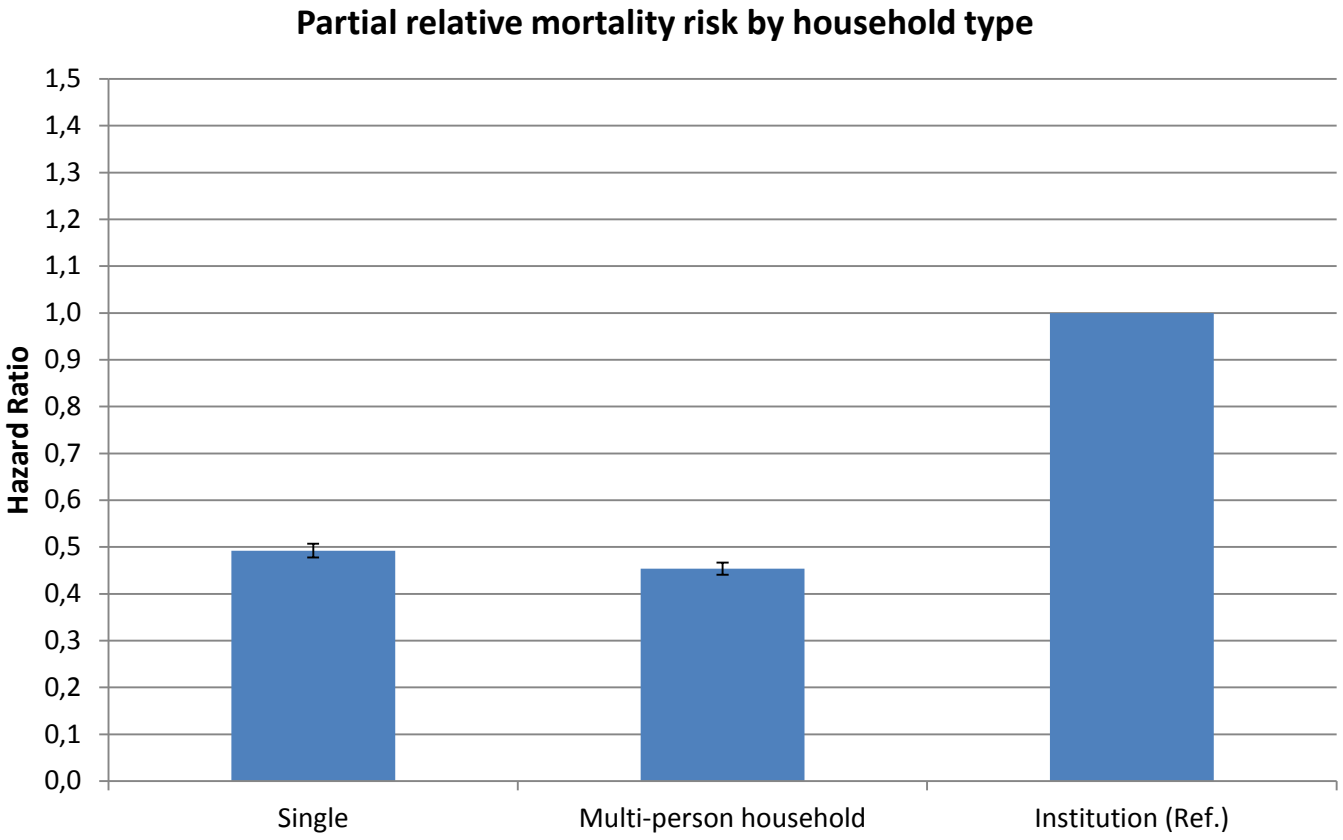
Vital status



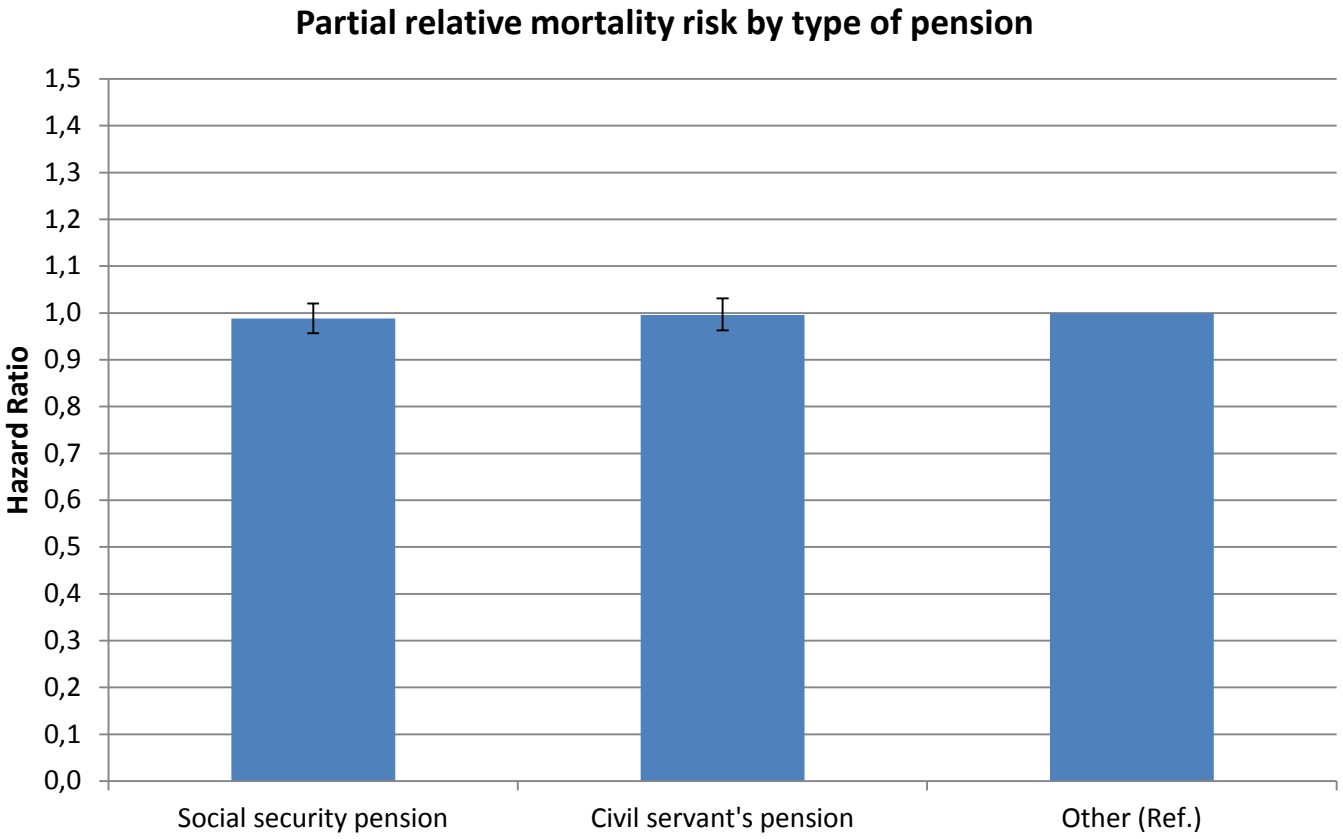
Method

- Around half of all men (49 percent) died in the five years of technical follow-up
- As expected, the frequency of deaths increases with age
- Proportional hazards regression model controlling for age, allowing for unequal follow-up time
  - Model I: without level of care
  - Model II: w/ level of care (social security pensions)

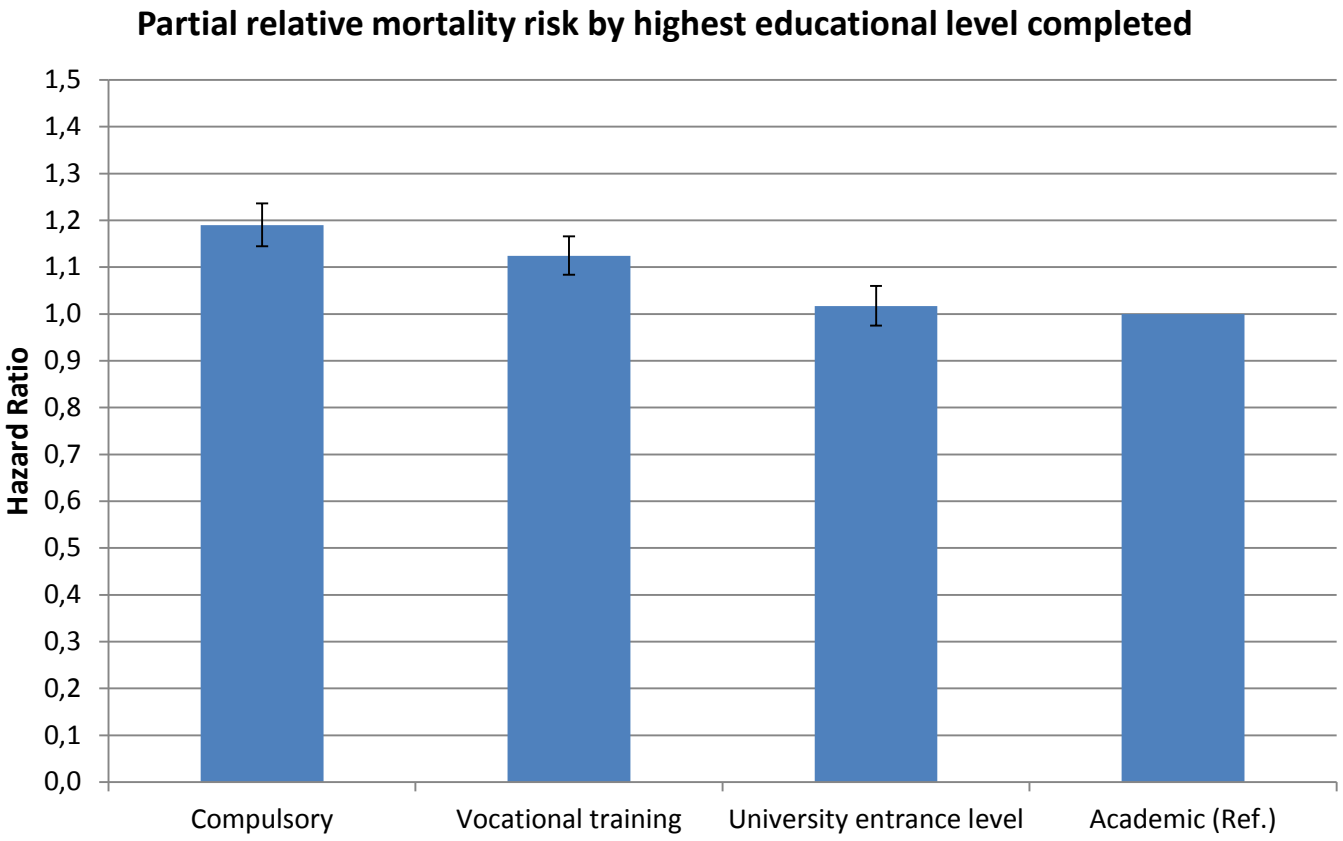
Hazard ratios (Model w/o care level)



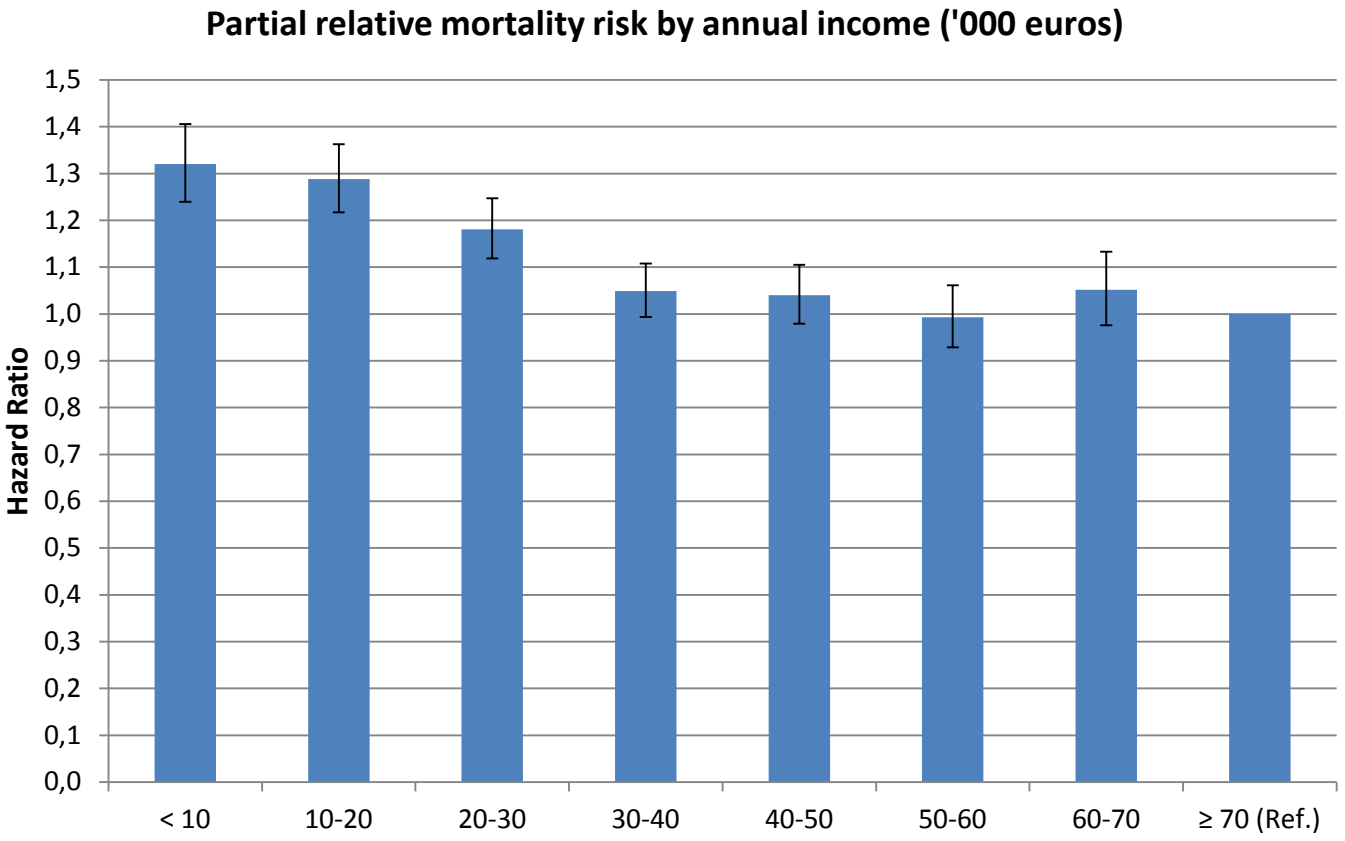
Hazard ratios (Model w/o care level)



Hazard ratios (Model w/o care level)



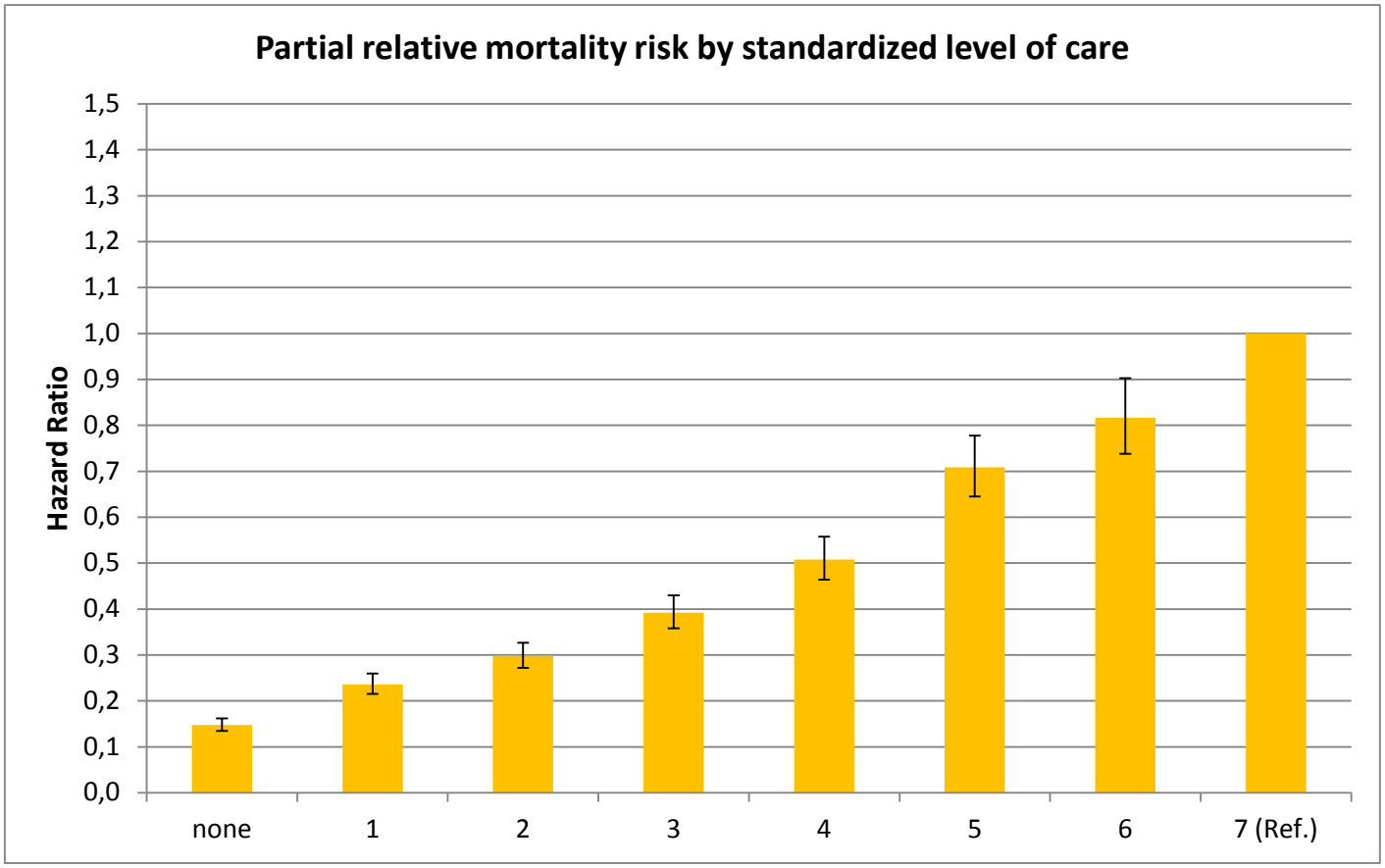
Hazard ratios (Model w/o care level)



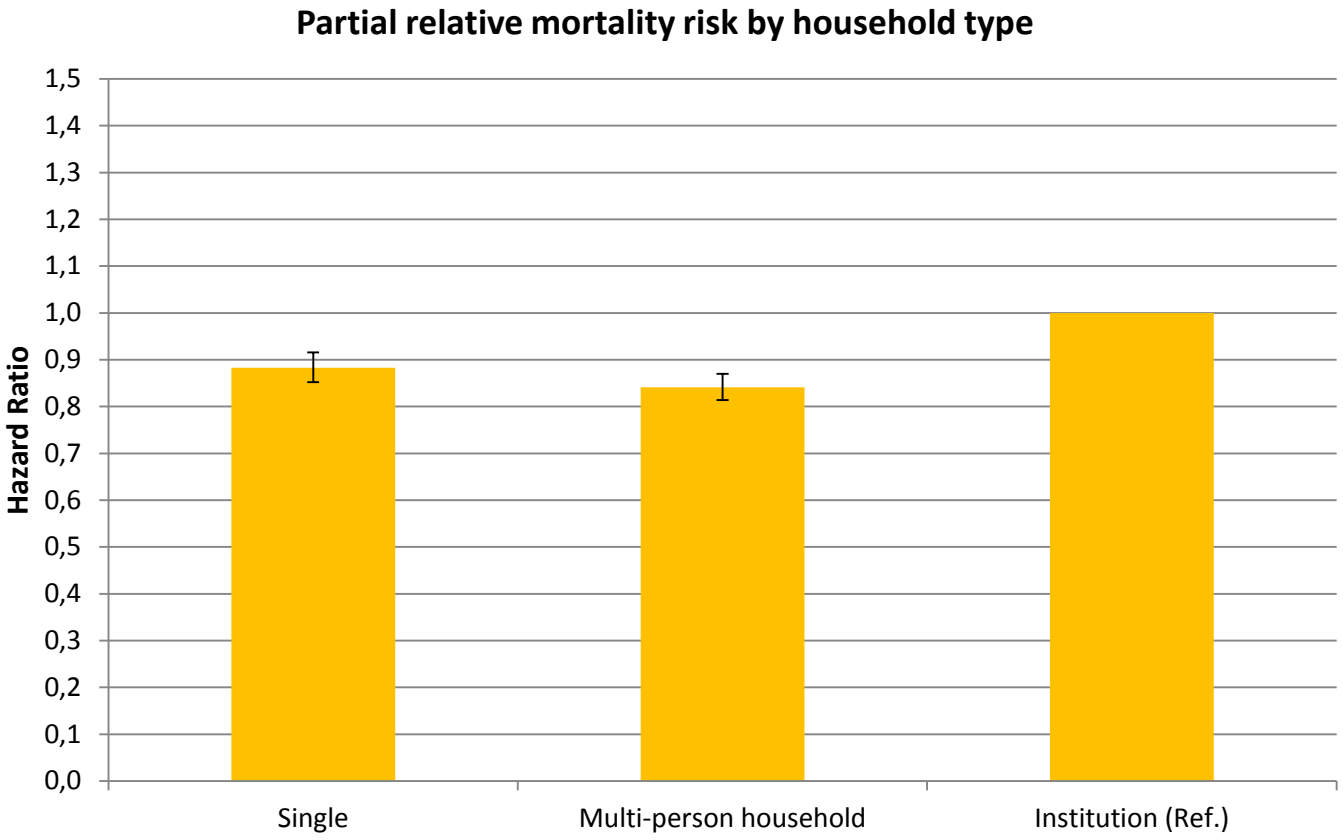
Findings (Model w/o care level)

- Even at highest ages significant mortality disparities between socio-economic groups can be observed
  - Systematic effect for educational level
  - Poverty effect for income level
- Type of pension insignificant when controlling for education and income
- Expectably higher mortality among the institutionalized population (reverse causation); little difference between men in multi-person households and singles (mostly widowers)

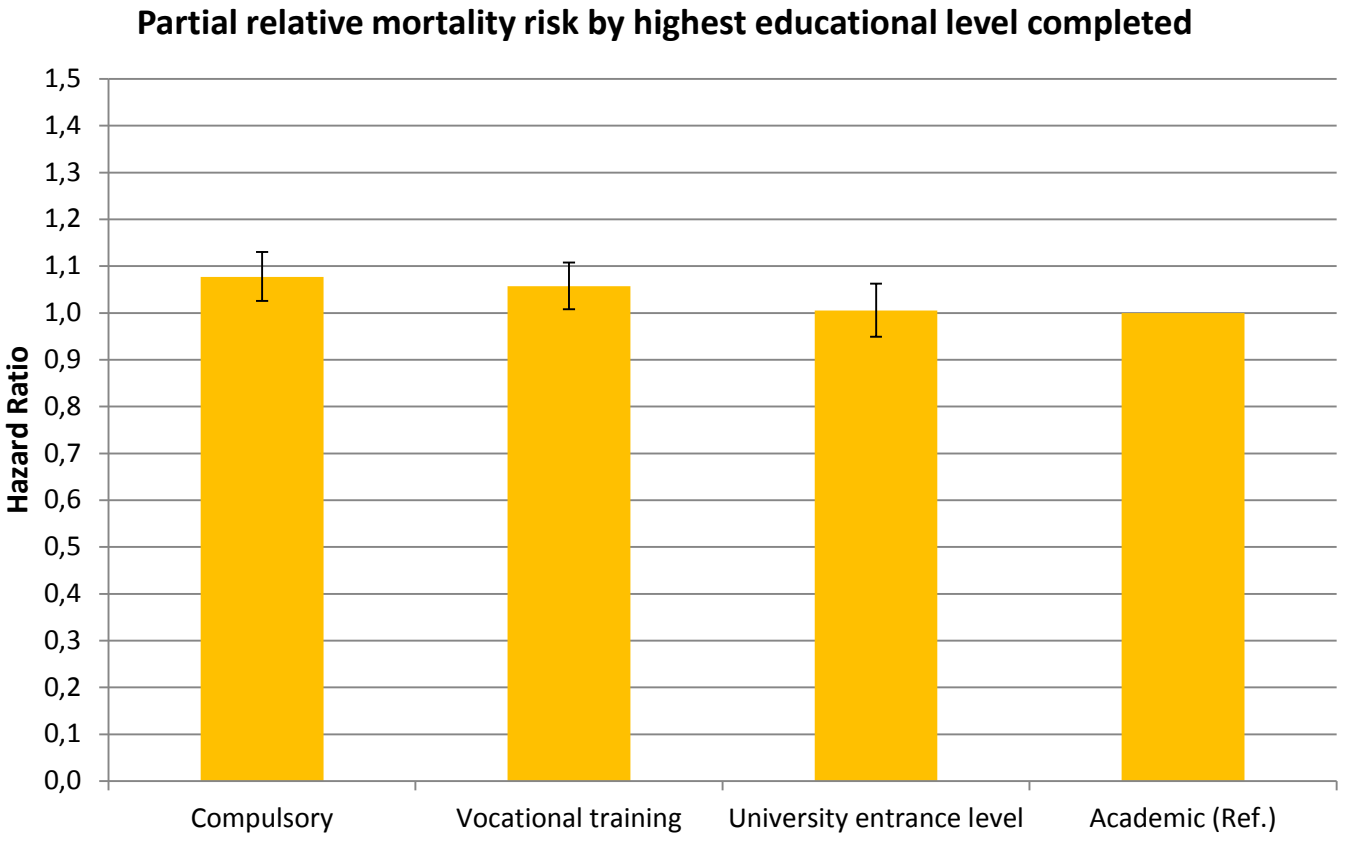
Hazard ratios (Model w/ care level)



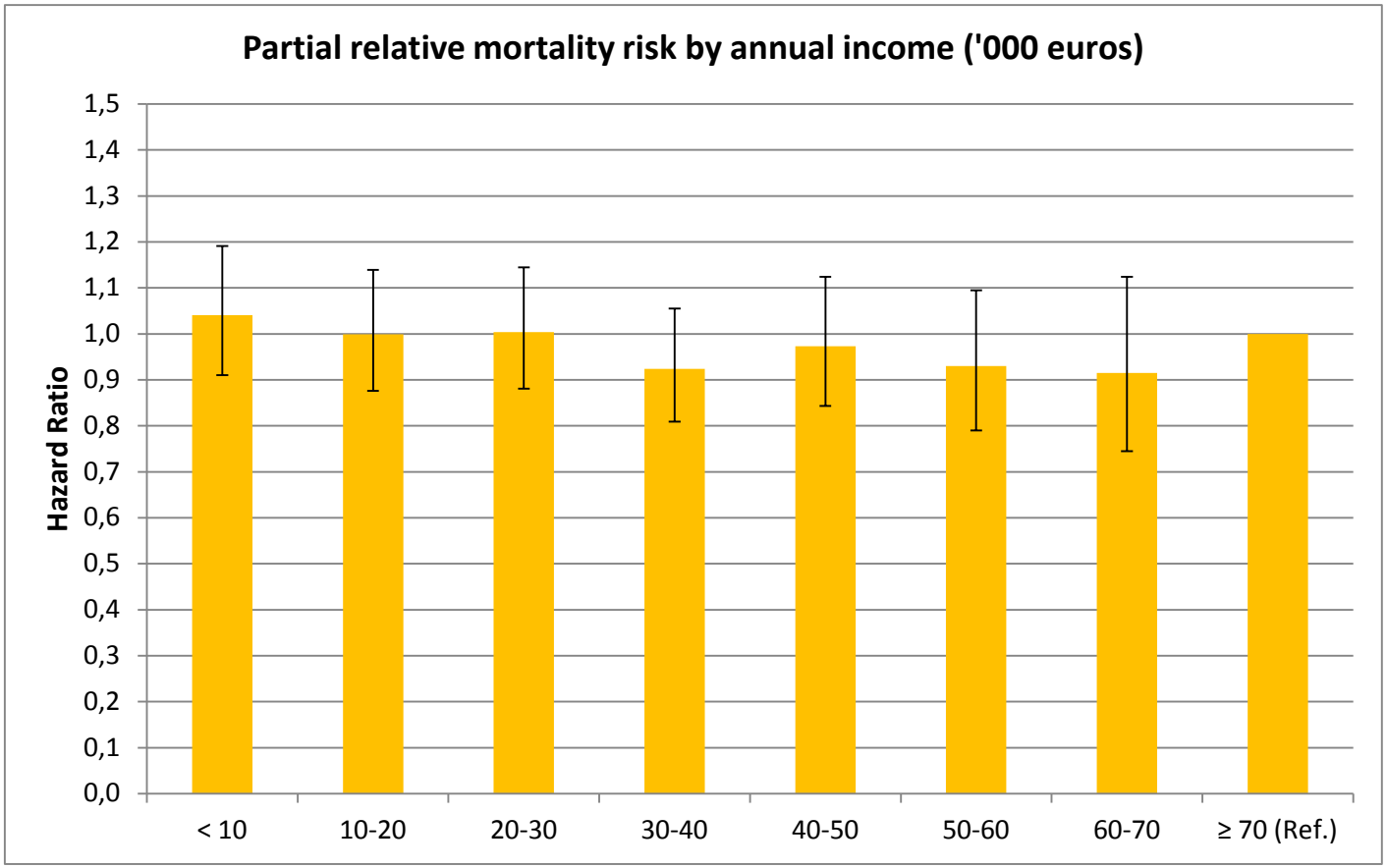
Hazard ratios (Model w/ care level)



Hazard ratios (Model w/ care level)



Hazard ratios (Model w/ care level)



Findings (Model w/ care level)

- Standardized level of care has enormous impact on mortality risk
- Controlling for level of care, partial effects are
  - negligible for education and income
  - small for household type
- At highest ages, mortality risk is essentially a function of age and level of care (‘frailty’)
- High social status influences mortality essentially via its influence on morbidity

Outlook

Forthcoming paper:

J. Klotz, T. Göllner and N. Gumprecht (2018): “Zu reich, um jung zu sterben? Determinanten der Mortalität bei hochaltrigen Männern in Österreich”