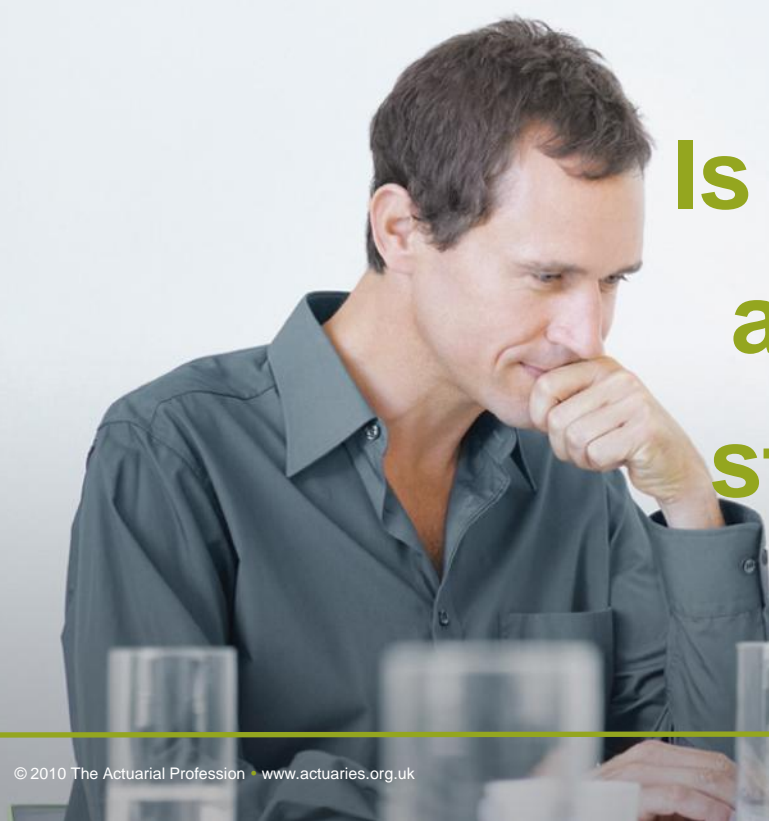


Emerging trends in mortality and longevity symposium 2011

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Anton Brink



Is the loss of gender as a rating factor a major step backwards in risk assessment?

12th September 2011

Agenda

- Why are we here?
- Summary of theories for gender mortality differentials;
- Evidence of gender mortality differentials;
- Potential use of Individualised risk factors;
- Practical Applicability to life assurance;



Is the loss of gender as a rating factor a major step backwards in risk assessment?

Why are we here?

Woman live longer than men (on average)

- Well established fact:
 - Since the mid 18th century
 - 2009 data suggests true in 187 / 193 countries
- Well studied by academics for many years;
- Actuaries have generally been led by the statistics to drive gender differentiated pricing bases...
- ...unless challenged by legislation



Advocate General

“Differences in treatment could at most be justified by clearly demonstrable biological differences between the sexes”

“.. the Advocate General is of the opinion that the exception in question does not relate to any clear biological differences between insured persons...”

However, many other factors also play an important role in the evaluation of insurance risks. Thus, the life expectancy of insured persons is above all strongly influenced by the economic and social conditions of each individual, such as, for example, the kind and extent of the professional activity carried out, the family and social environment, eating habits, consumption of stimulants and/or drugs, leisure activities and sporting activities...”

Differences between people, which can be linked merely statistically to their sex, must not lead to different treatment of male and female insured persons

Legislating for Facts

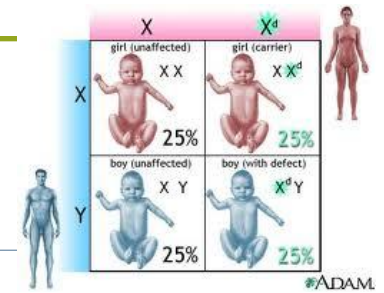
*“Legislation will not make the mortality rates of males and females equal, any more than the proposed legislation by Indiana State Legislature in 1897 that the value of π was 4 made it so; instead it just made the legislators look foolish”
(Wilkie 1984)*



Is the loss of gender as a rating factor a major step backwards in risk assessment?

Theories Explaining Gender Mortality Differentials

Biological Theories - Chromosomes



- The X chromosome contains genes which govern processes other than gender-determination. Females with 2 X chromosomes may gain an advantage, because :-
 - A male who receives from one parent abnormal genetic information from his X chromosome, does not have the opportunity to neutralise the trait, because he lacks a second X chromosome.
 - A female may be able to make up for the abnormality through her second X chromosome.
- It is thought that this may lead to advantages for females in respect of the immune system and blood clotting capabilities.
- Research published in 2009 identified gene Rasgrf1, only active in males, as having a detrimental effect on longevity.

Biological Theories – Telomeric Shortening



- Telomeres are the 'book ends' of the chromosomes, which shorten at each cell division.
- When telomeres reach a critical length, cells cease to divide and damage accumulates
- At a given age, telomere shortening is more advanced for males than females (Cherif *et al* 2002)

Biological Theories - Hormones

Male Testosterone

- Provokes blood pressure, increases LDL, decreases HDL, thus enhancing cardio-vascular risk.
- Increases aggression and risk-taking.
- Alters brain development, reduces symmetry and brain connectiveness, possibly impeding stroke recovery.

?
Kay-Tee Khaw
et Al (2007)

Female Estrogen

- Appears to be protective against cardio-vascular risks.

Behavioural Theories – Males Prone to....

- More drinking, smoking, drug-consuming;
- More driving;
- More aggression;
- More stressful occupations
- Consult doctors less, follow medical opinion less faithfully.
- Have less frequent social interactions.
- May subconsciously fear living on their own (Goldberg 1976)



Behavioural Theories – But males traditionally...

- Had higher average incomes;
- Had greater education;
- Were more likely to be married;
- Exercised more.

Is imbibing harmful substances **biological** or **behavioural**?



Even in monkeys, voluntary alcohol drinking is higher in males. 54% of males consumed enough alcohol to become intoxicated, compared to 24% for females. (Fitzgerald et al 1968)

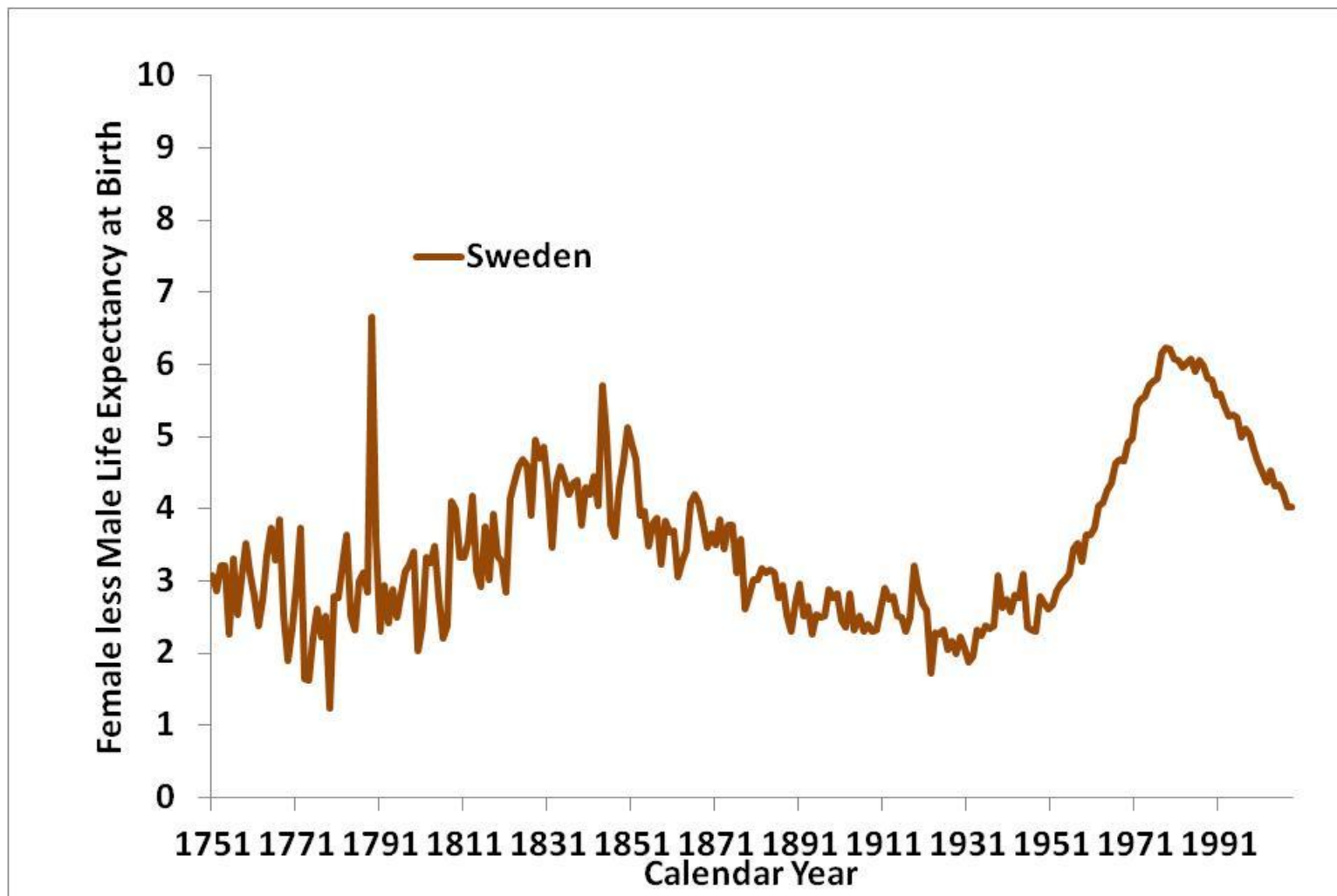
Behavioural differences are strongly influenced by biology



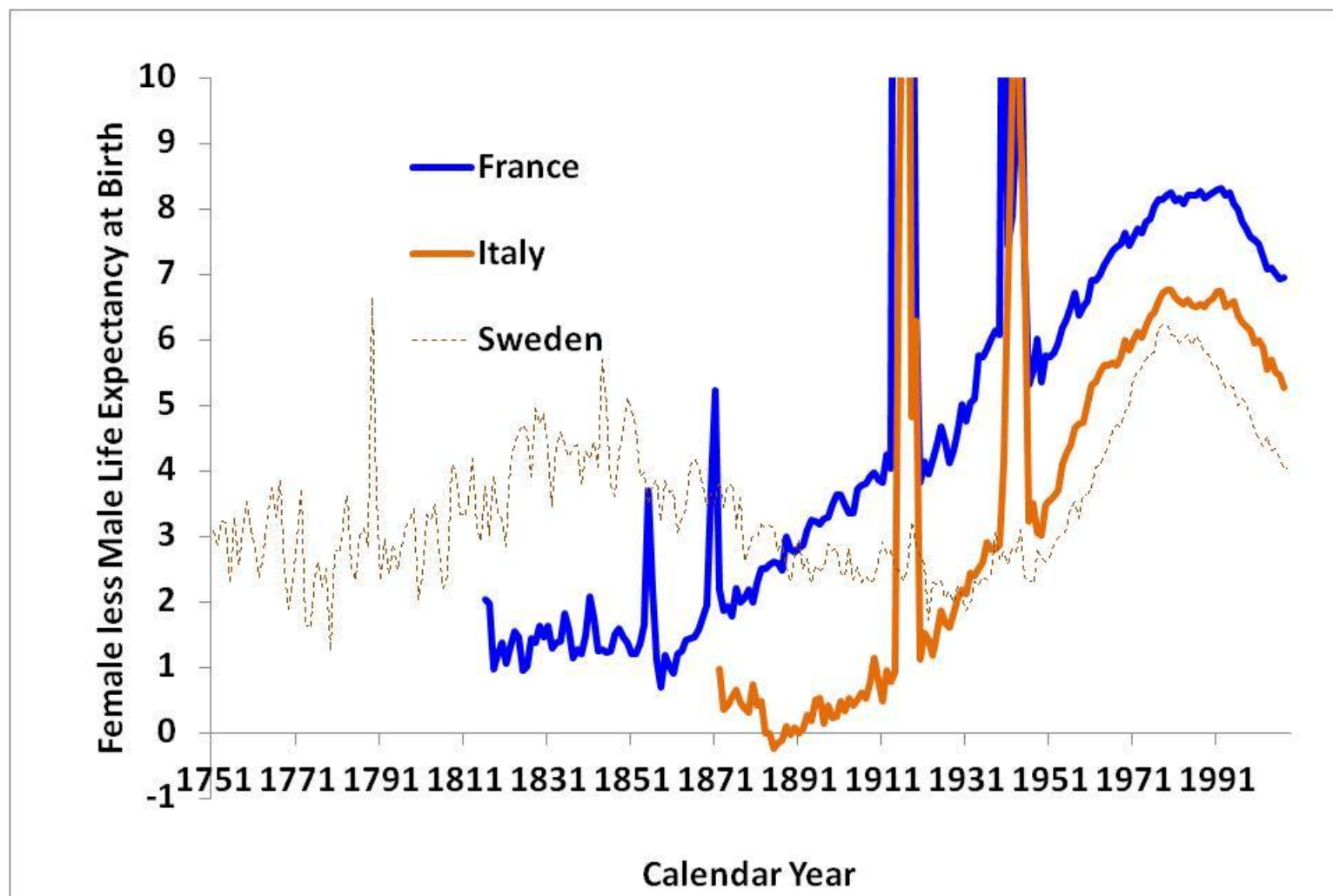
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Evidence of Gender Mortality Differentials

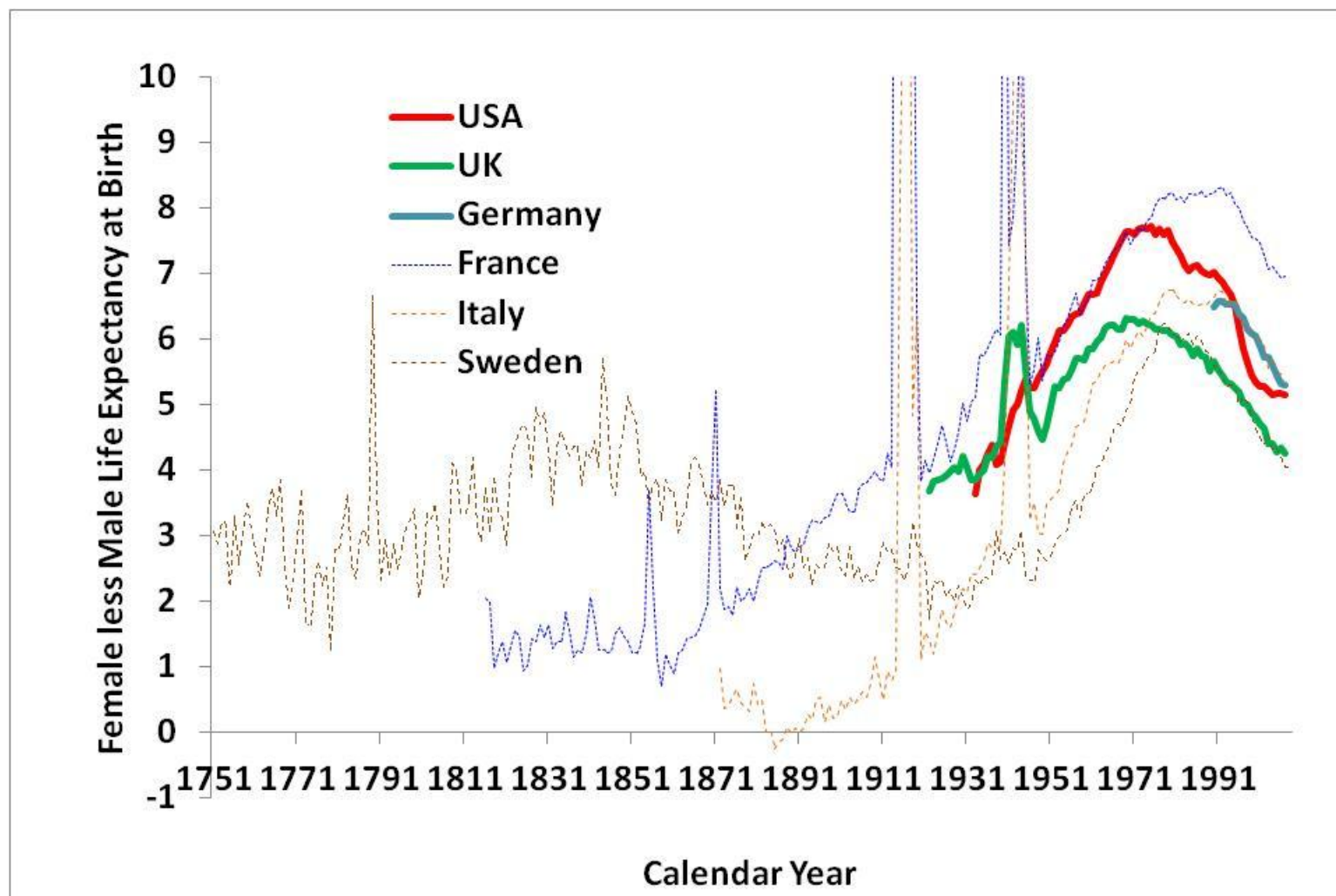
Female less Male Life Expectancy at Birth



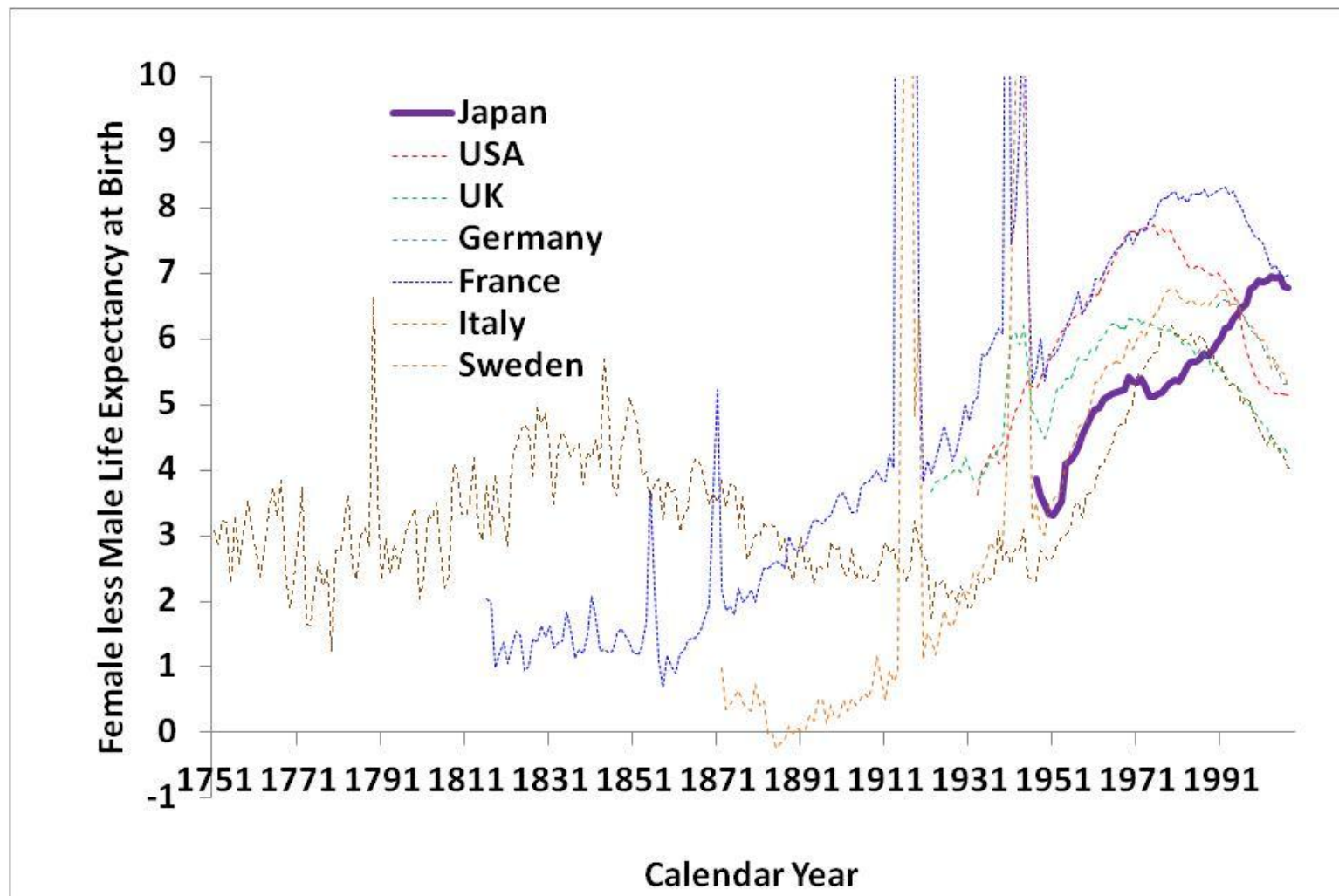
Female less Male Life Expectancy at Birth



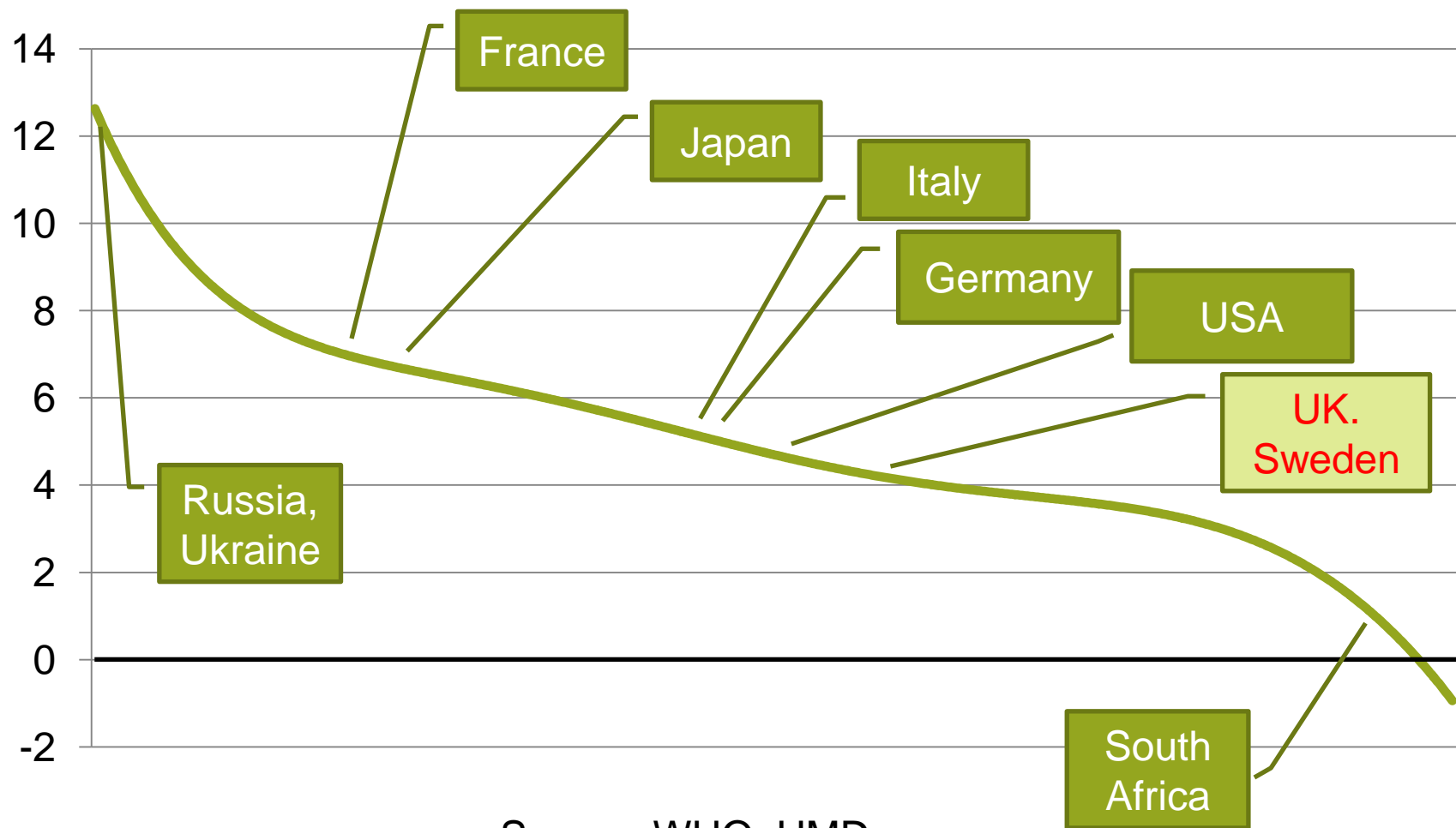
Female less Male Life Expectancy at Birth



Female less Male Life Expectancy at Birth



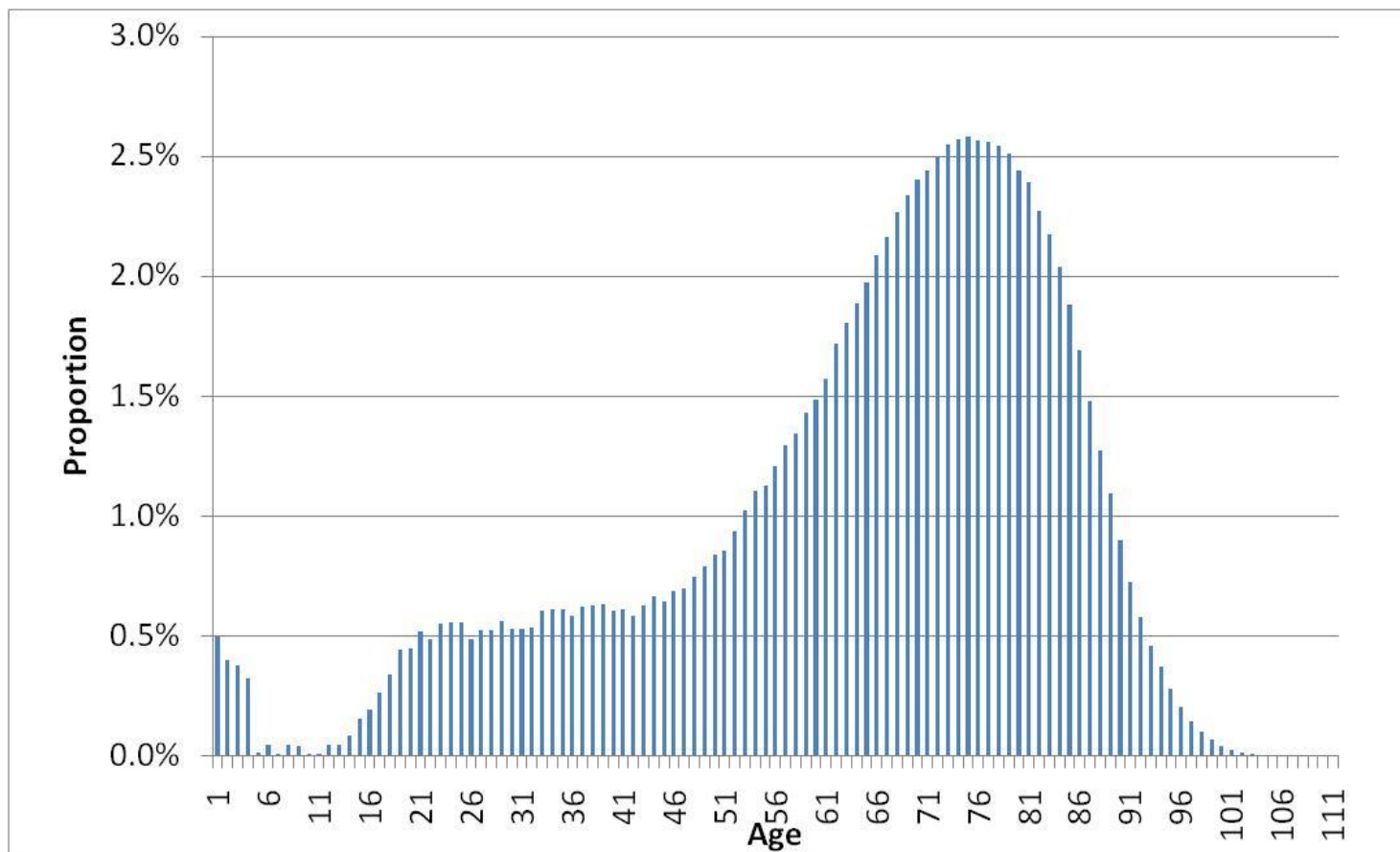
International Differences in Life Expectancy at Birth in 2009



Source: WHO, HMD

UK Gender Differences

Proportional Contribution to Difference in Life Expectancy at Birth, By Age



Formula used to apportion difference is :-

$$\Delta_x = [(e_x^f - e_x^m)(l_x^f + l_x^m)/2] - [(e_{x+1}^f - e_{x+1}^m)(l_{x+1}^f + l_{x+1}^m)/2]$$

Results smoothed by 7 year rolling average.

Heat Chart of England & Wales Gender Mortality Ratios

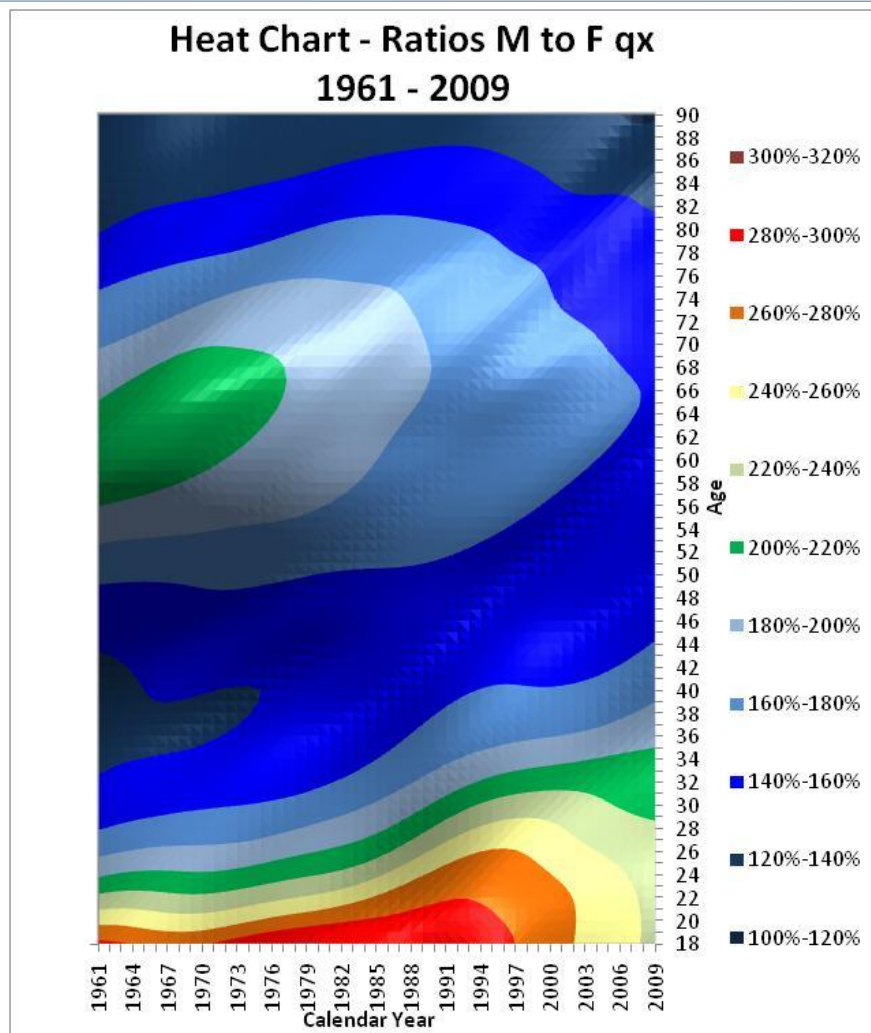


Chart shows ratio of smoothed population qx rates, using p-spline for smoothing

Gender Comparisons by Species

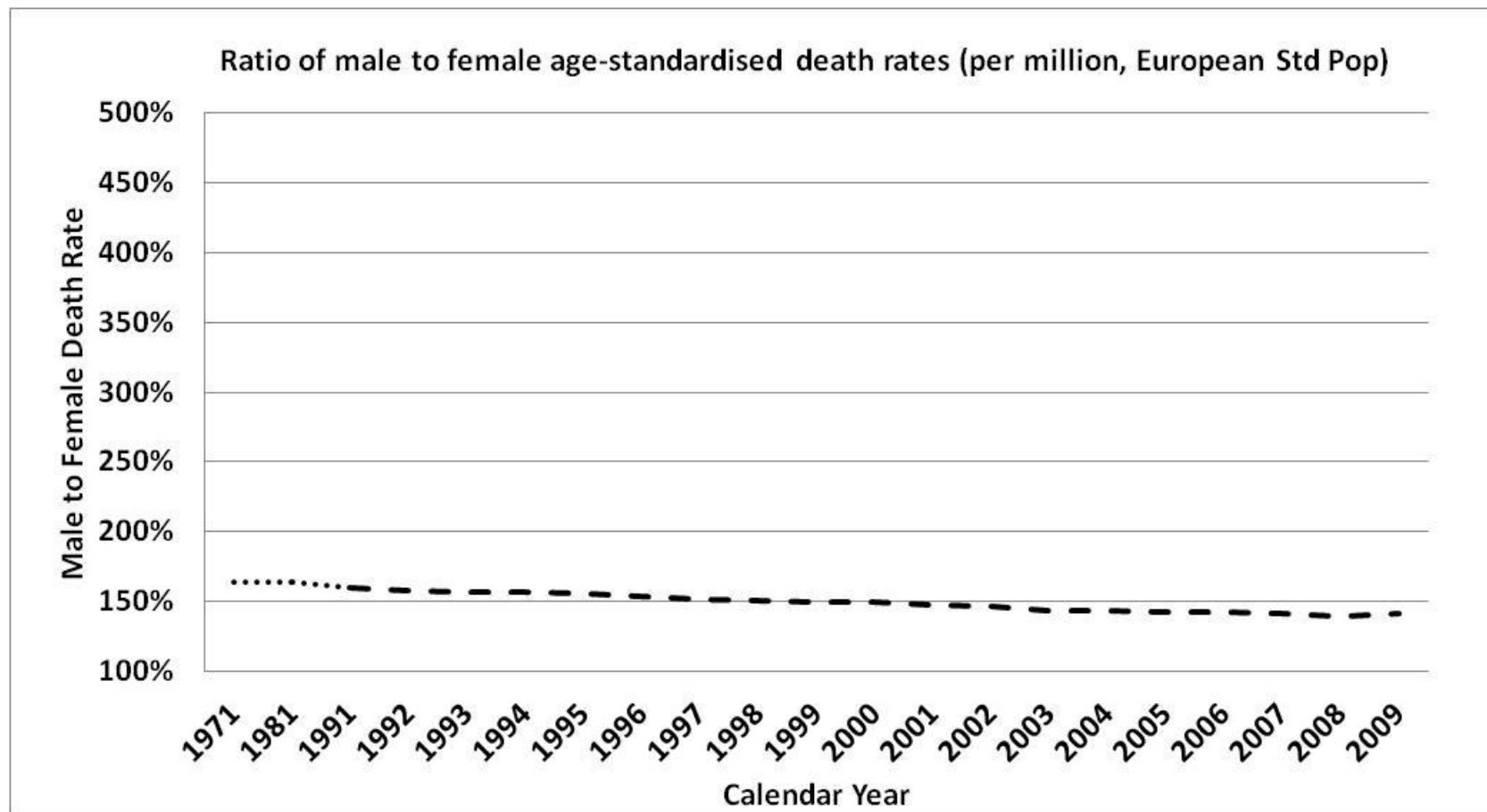
Male mortality heavier:

- Nematodes
- Crustaceans
- Molluscs
- Insects
- Spiders
- Reptiles
- Fish
- Mammals

Female mortality heavier:

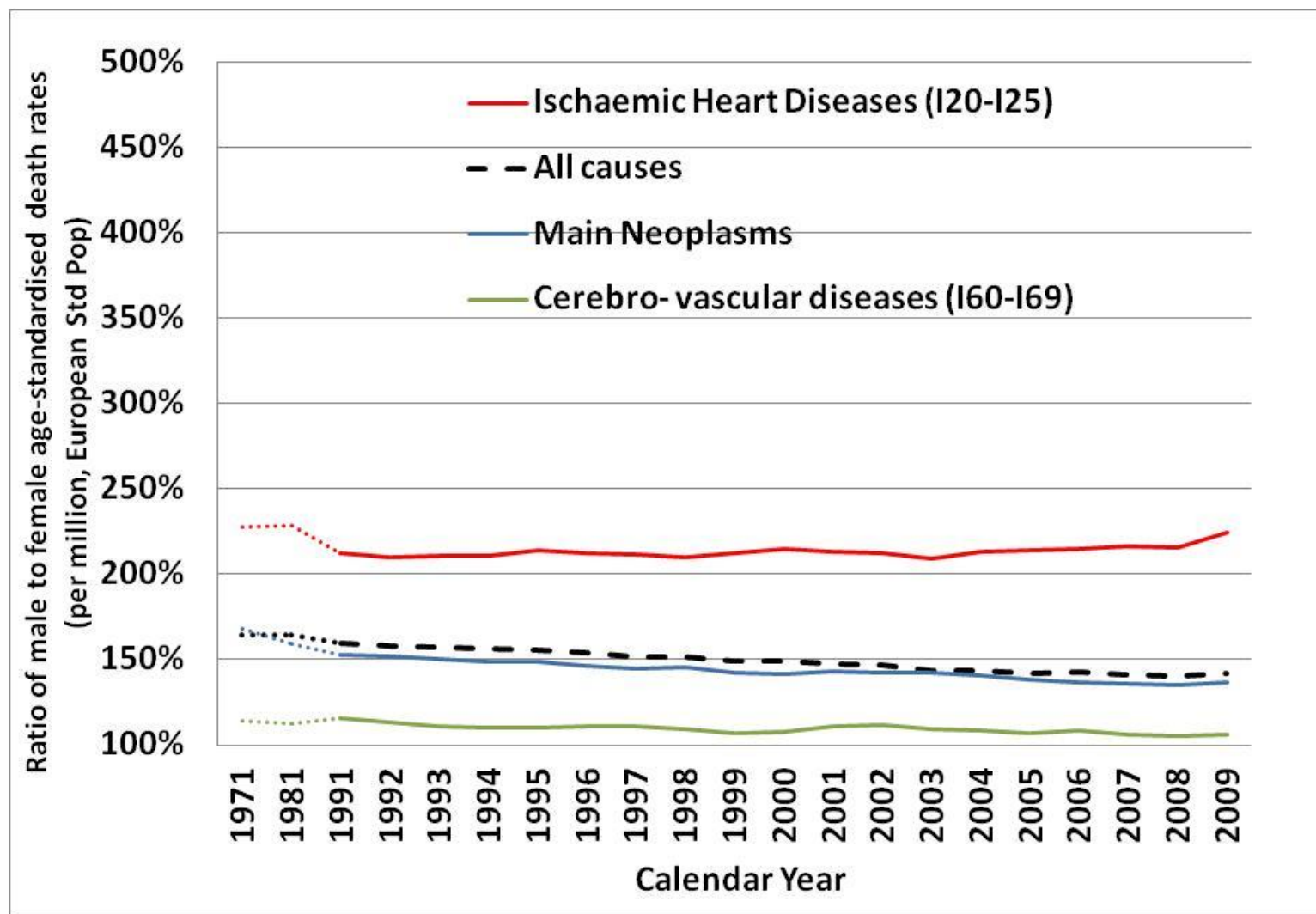
- Some birds...the feathered variety

Gender Differences – Mortality By Cause



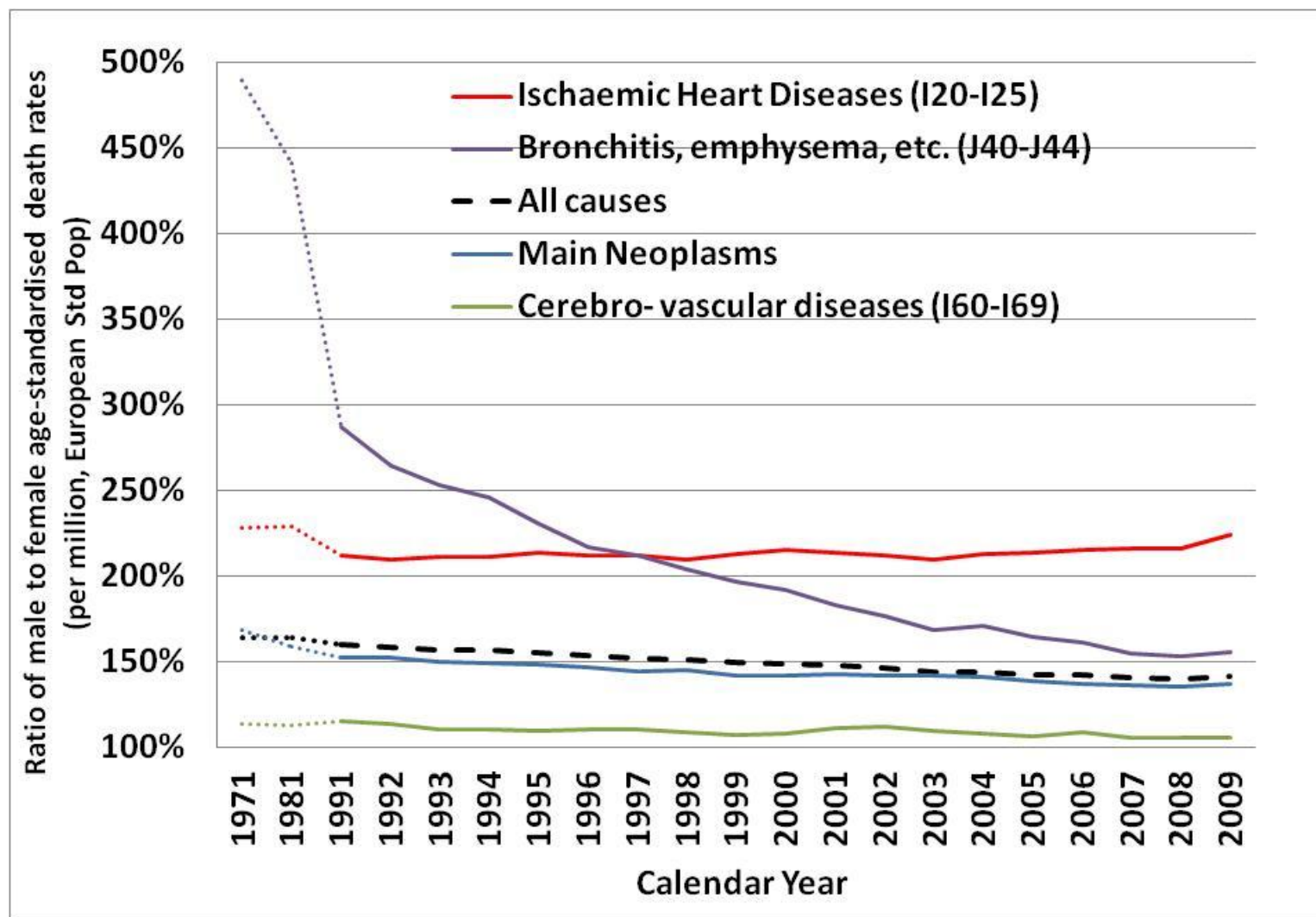
The ratio exceeds 100% for nearly all age-groups !

Gender Differences – Mortality By Cause



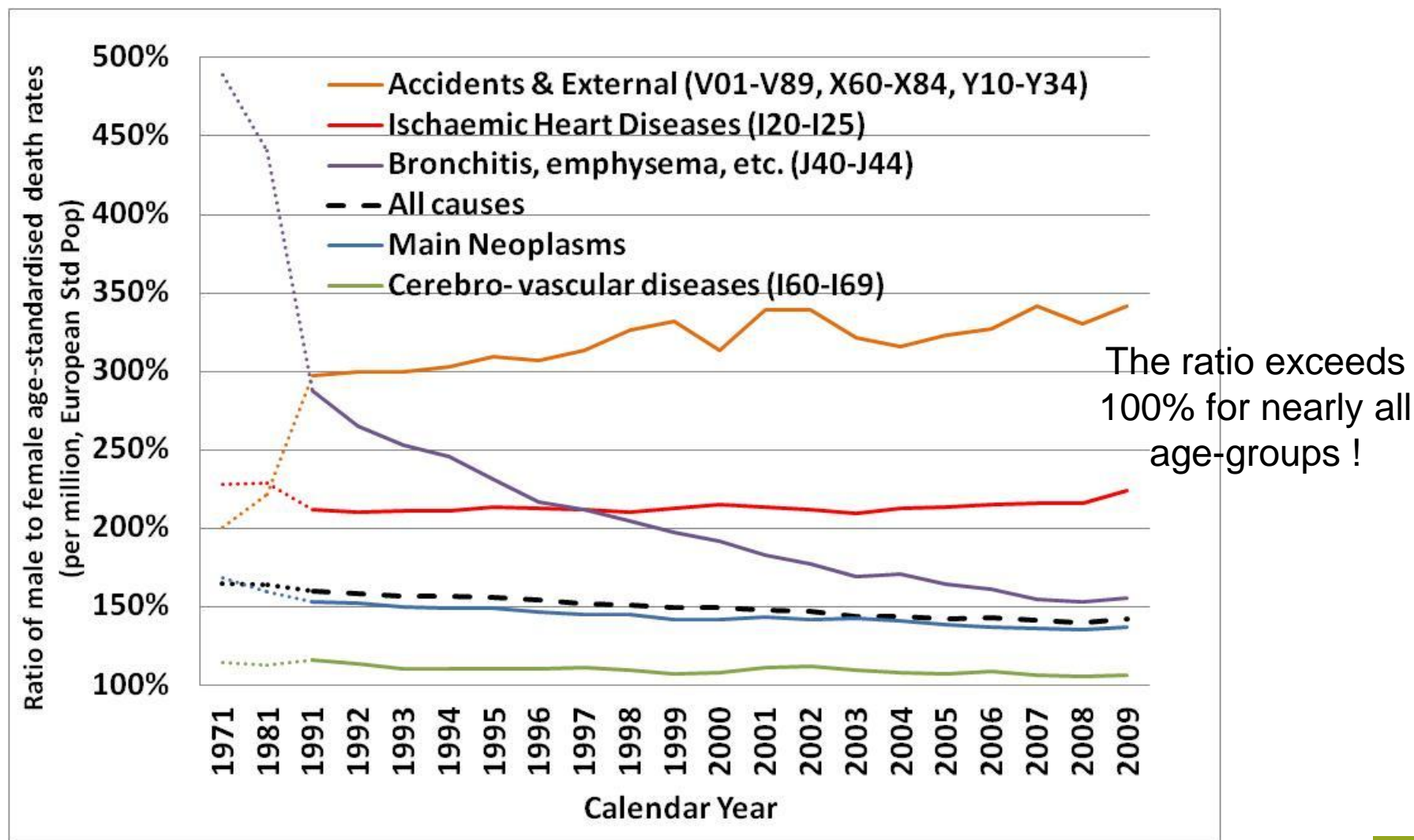
Source : ONS Statistics, Mortality By Cause 2009

Gender Differences – Mortality By Cause



Source : ONS Statistics, Mortality By Cause 2009

Gender Differences – Mortality By Cause





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Potential Use of Individualised Risk Factors

Section Overview

- Medical / Scientific studies
 - US, Rogers *et al* (2010);
 - West Germany, Luy *et al* (2006), Max Planck Institute;
- Studies of “standardised” groups;
 - Monks and Nuns
 - Kibbutz mortality
- Individualised Risk Factor Conclusions
- Insurance Data analysis;

Statistical Study – U.S. Rogers *et al* (2010)

National Health and Nutritional Examination Survey

Gender mortality differences in a U.S. population survey for ages ≥ 20 , controlling for differences in gender distribution of both biological and behavioural factors.

Behavioral

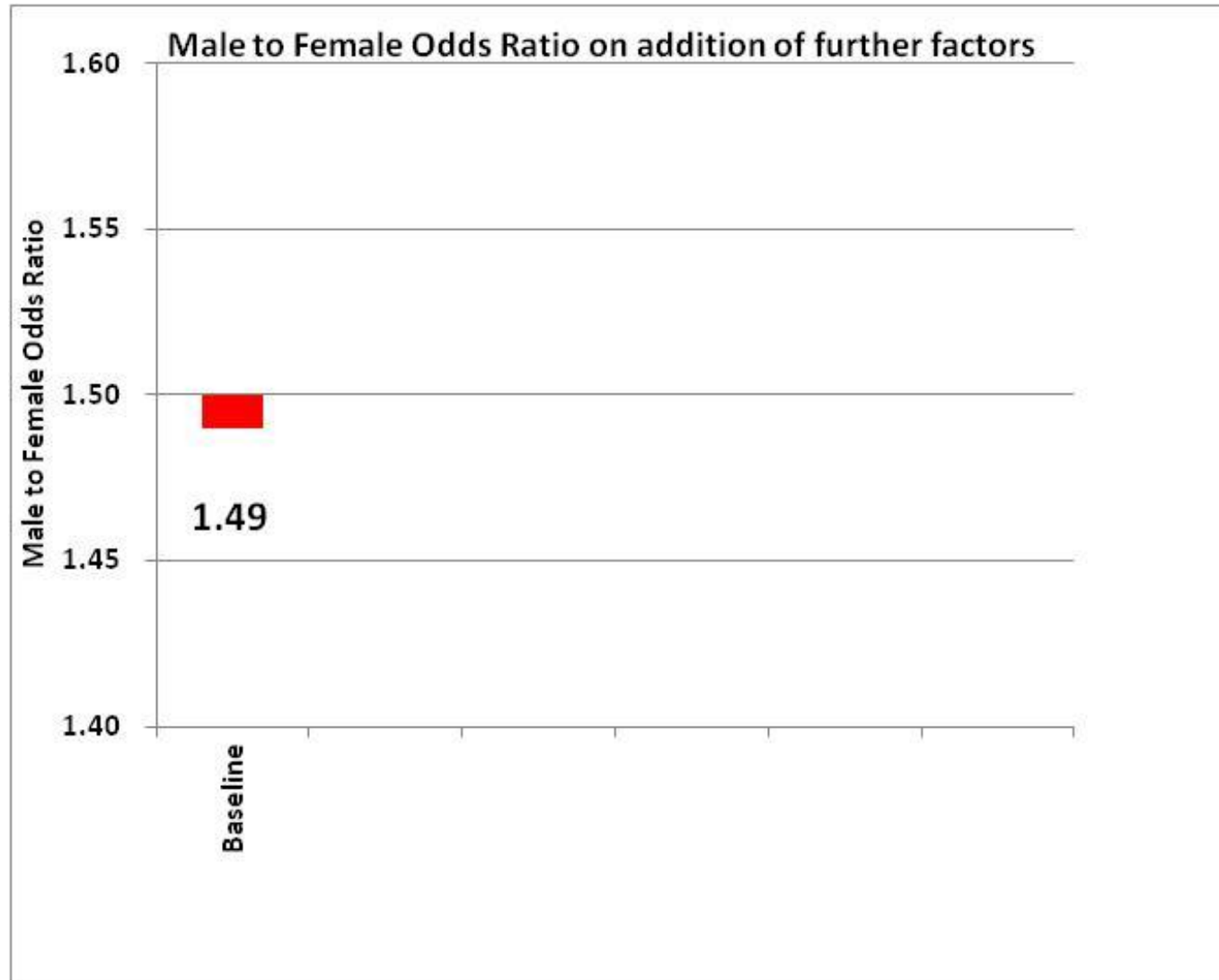
- Socio-economic
- Marital status
- Social and religious activities
- Preventive health habits
- Risk-taking, incl smoking, alcohol, drugs
- Physical activity
- Stress

Biological

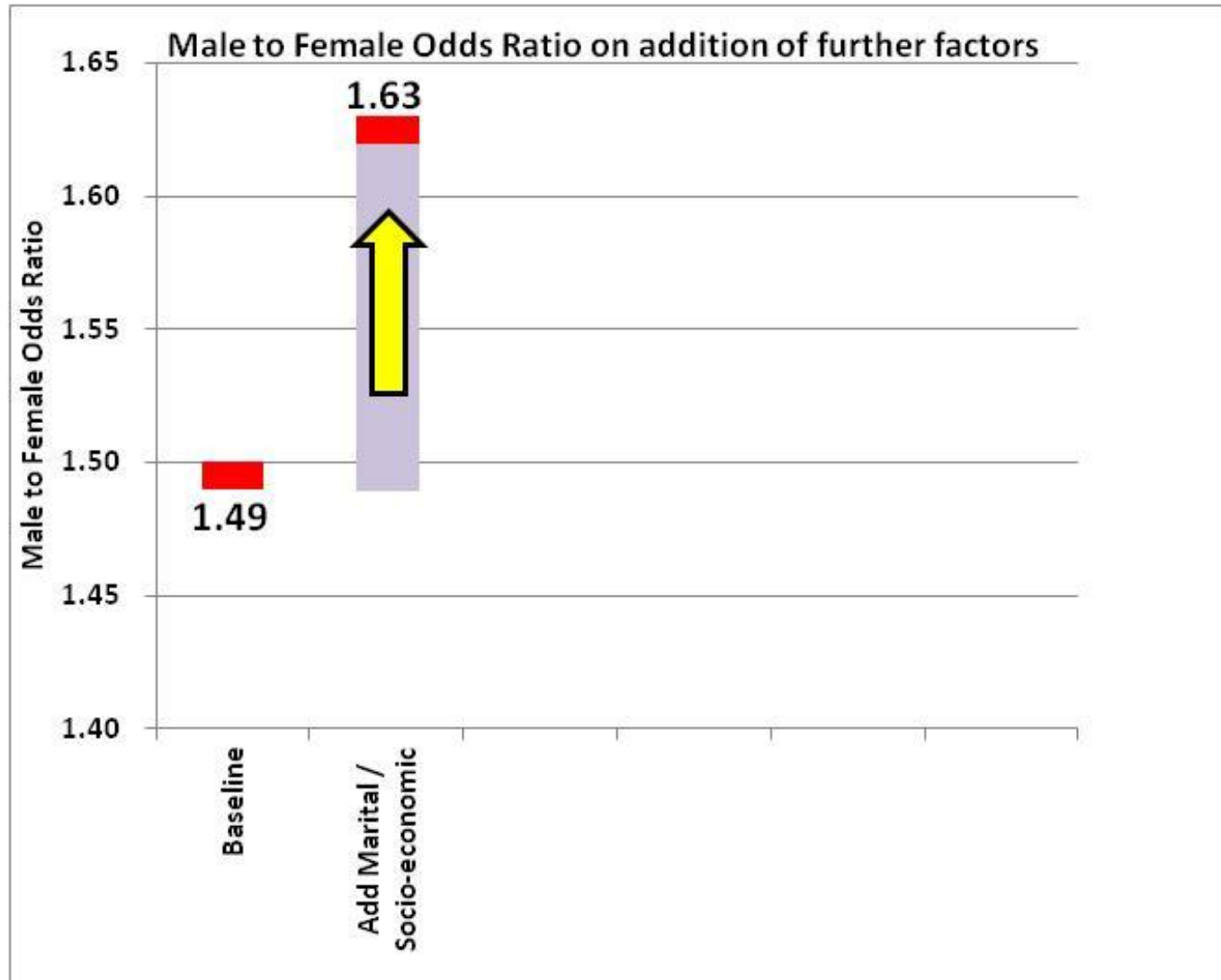
- Blood pressure
- Inflammation (albumin level)
- Cholesterol
- Glucose control
- Functional impairment (mobility)



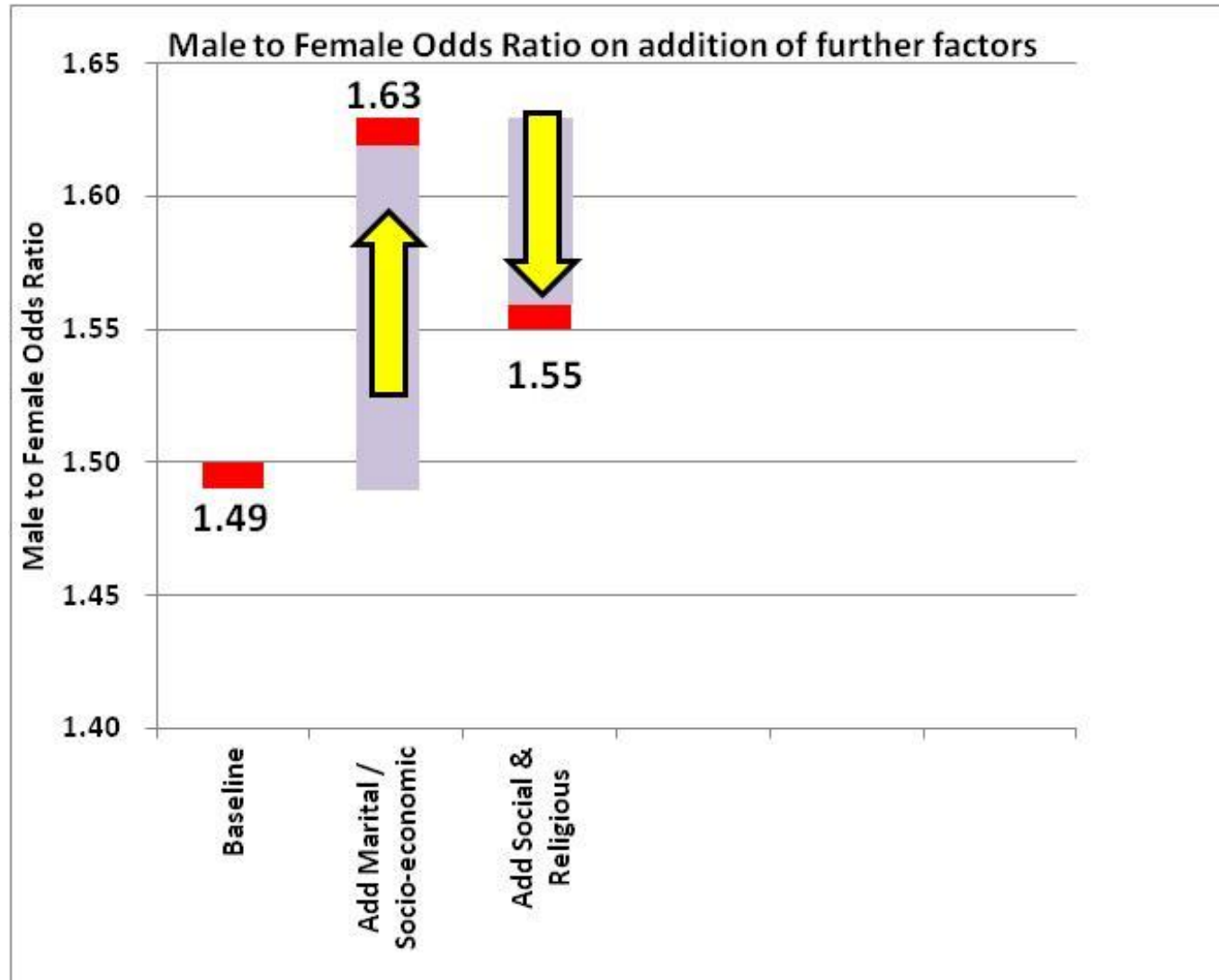
Statistical Study – Rogers *et al* (2010)



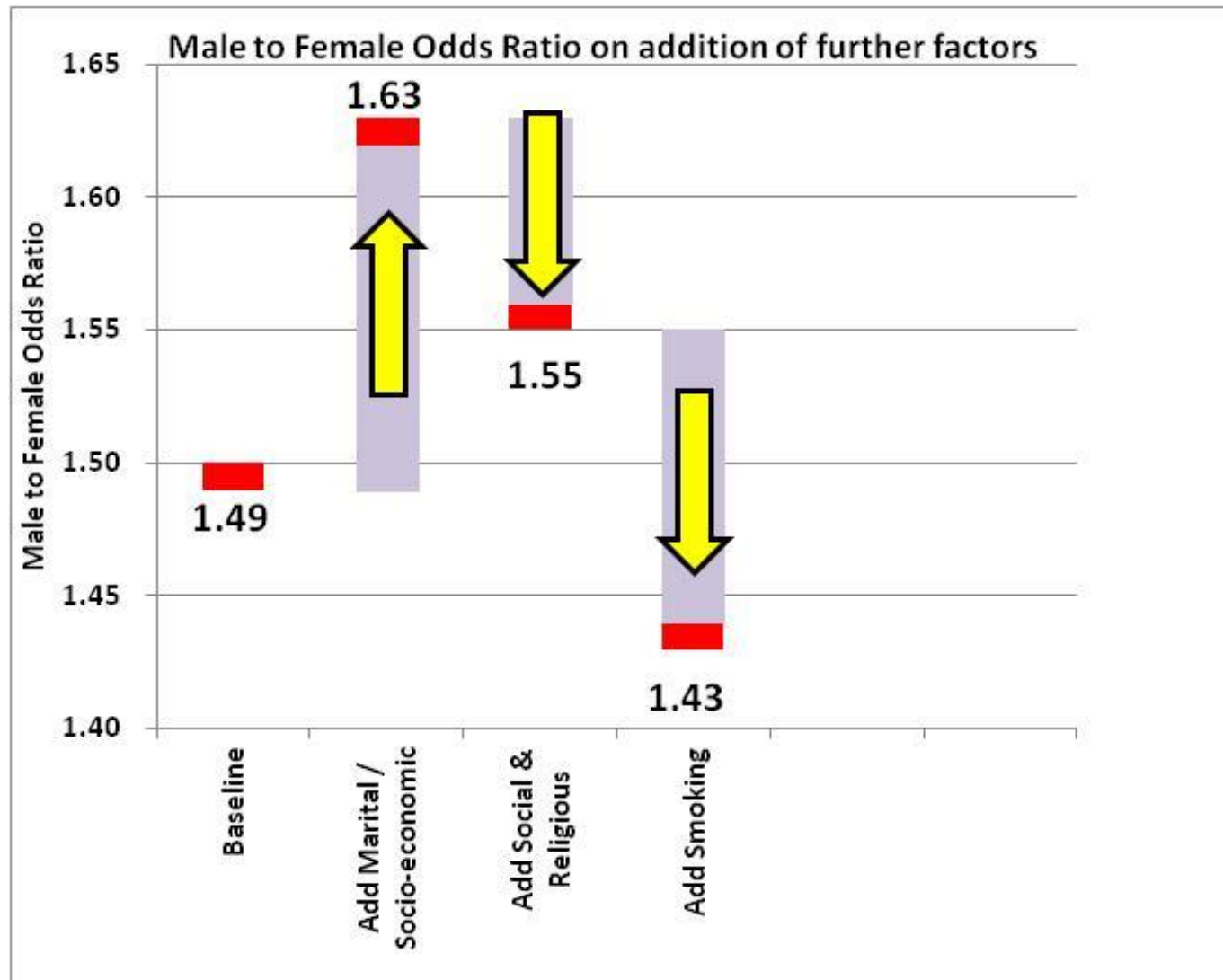
Statistical Study – Rogers *et al* (2010)



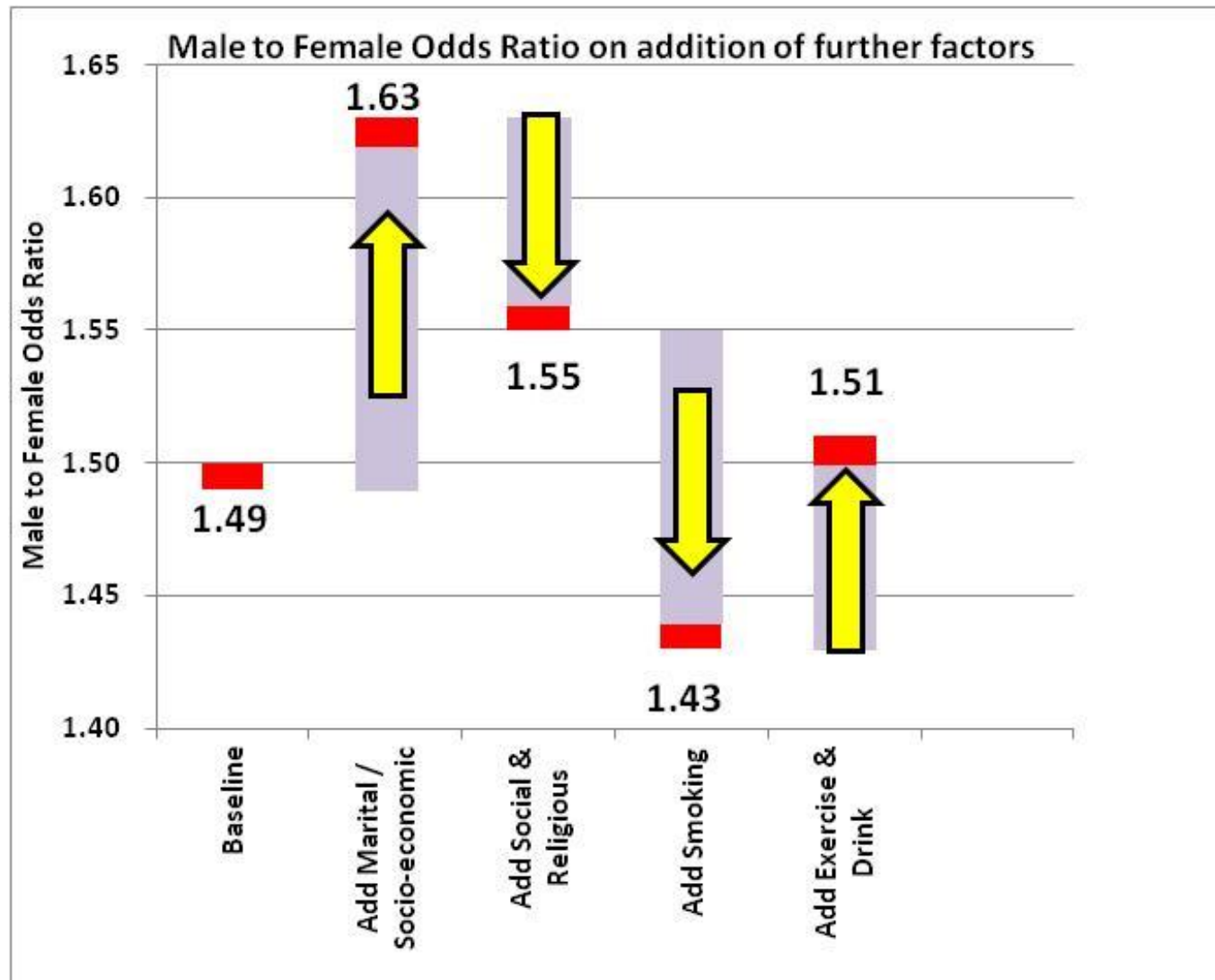
Statistical Study – Rogers *et al* (2010)



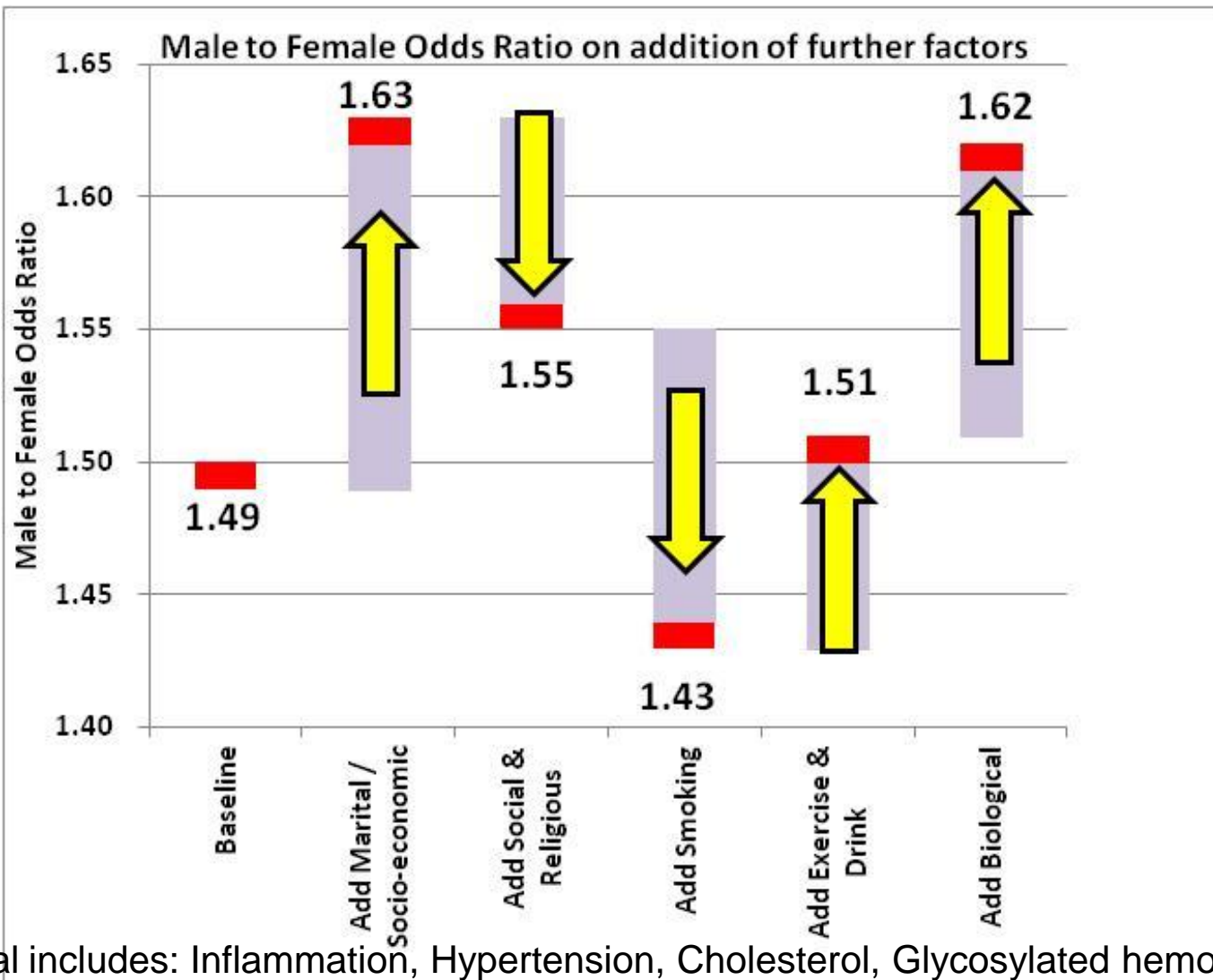
Statistical Study – Rogers *et al* (2010)



Statistical Study – Rogers *et al* (2010)



Statistical Study – Rogers *et al* (2010)



Statistical Study – Luy *et al* (2006)

Gender mortality differences in a West German population aged 60-69, controlling for differences in gender distribution of both biological and behavioural factors.

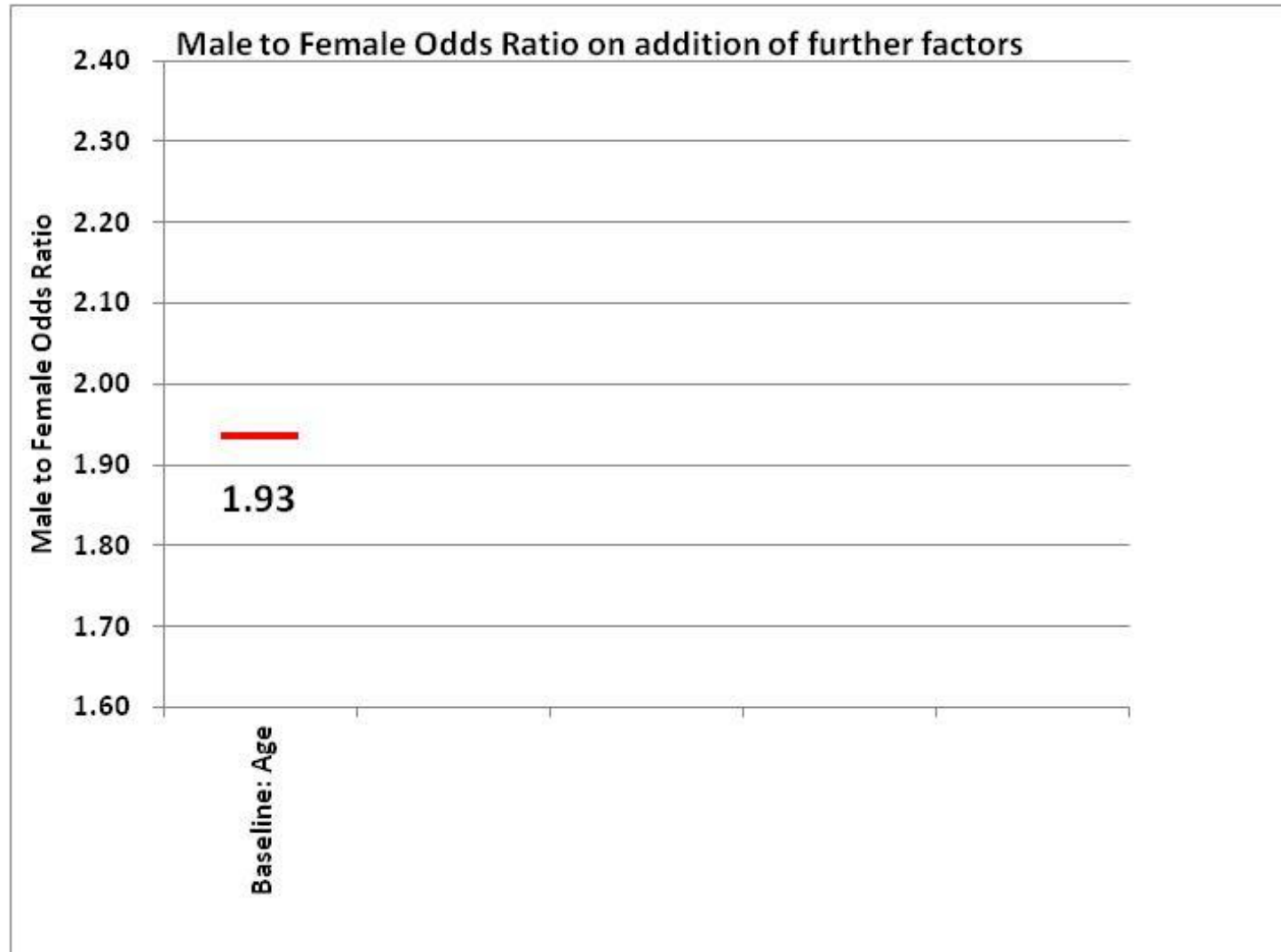
Behavioral

- Social Support: The number of people able to help in case of need
- Smoking, high proof spirits
- Physical activity
- Living arrangements
- Vegetables and fruit intake
- Previous stressful job
- Psychological Type A behaviour

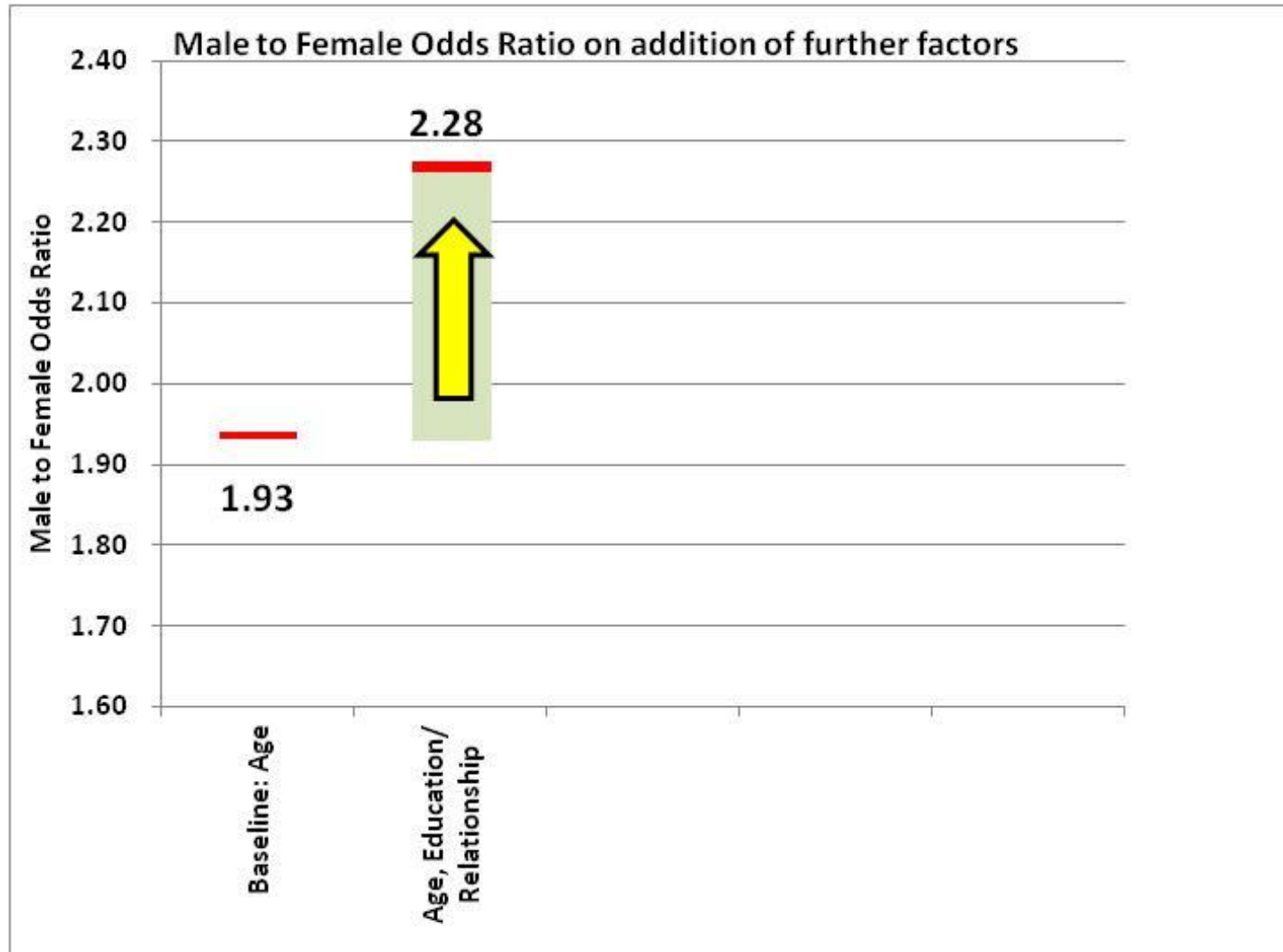
Biological

- BMI
- Intensity at which look after own health

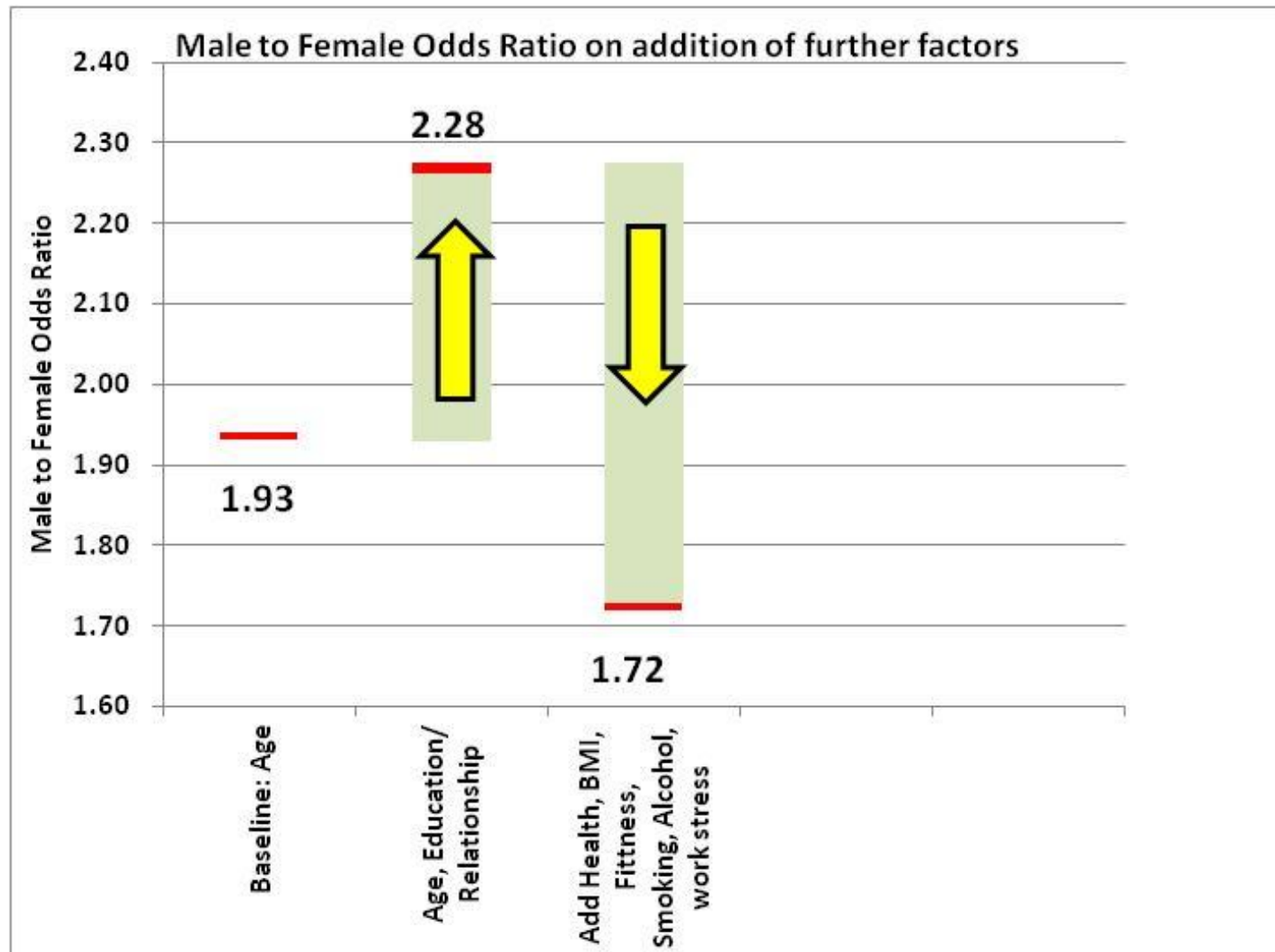
Statistical Study – Luy *et al* (2006)



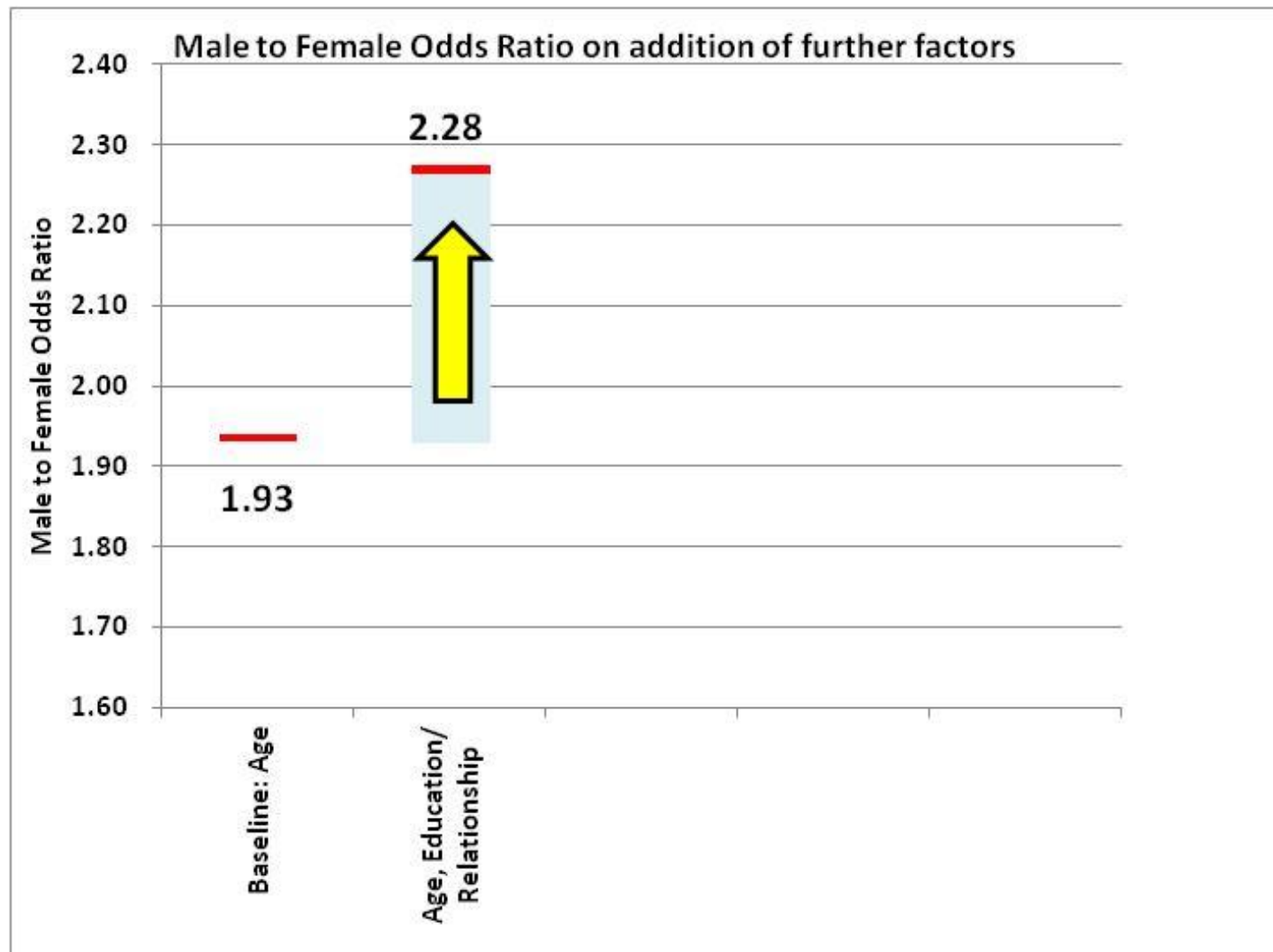
Statistical Study – Luy *et al* (2006)



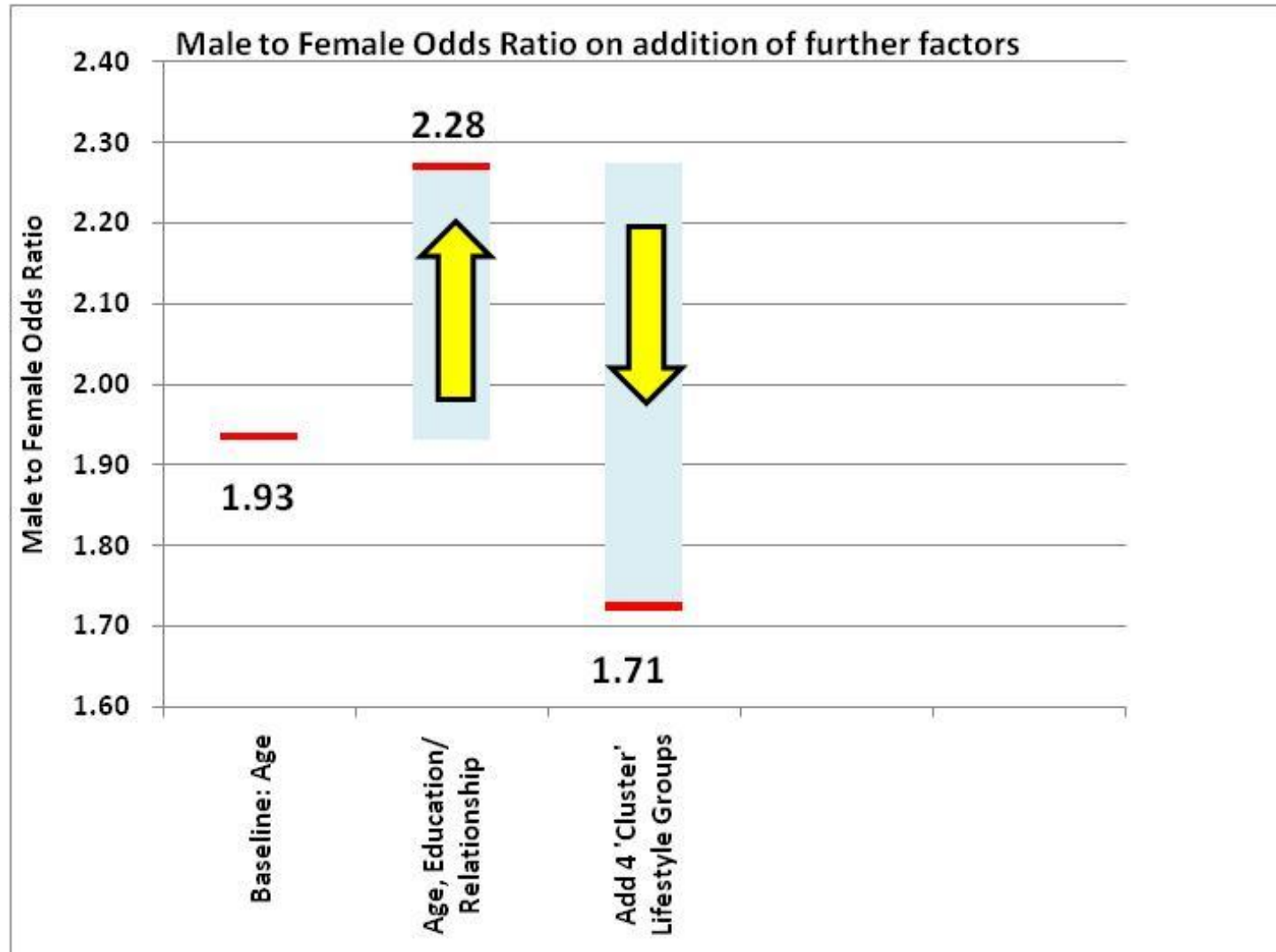
Statistical Study – Luy *et al* (2006)



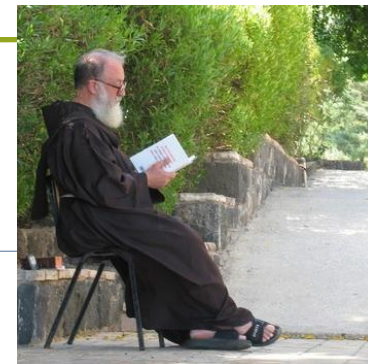
Statistical Study – Luy *et al* (2006)



Statistical Study – Luy *et al* (2006)



“Monks and Nuns”



- Madigan 1957: US Catholic Brothers & Sisters
 - Mortality differentials similar to general population => biological factors more important;
- Luy 2003 / 2009 - Bavarian nuns and monks
 - Narrower differentials than general population;
 - Divergence in mortality of monks from nuns from 1970's, possibly due to smoking allowance and road accidents!
- Not conclusive because:
 - Sample size small => wide confidence interval in results
 - Monks/nuns aging far faster than the general population
 - Not always totally isolated from environmental factors: nuns involved in teaching, monks travelling

Kibbutz Mortality- Leviatan & Cohen 1985

- Mortality differential for two Kibbutz communities in Israel
 - one committed to gender-equality:
 - Both sexes participate in public life, agriculture, housework and child care
 - Similar low-stress factors
 - community resources shared according to need
 - the other community based on strong religious values:
 - Traditional female and male roles maintained
- Both communities found similar mortality differentials
- A greater differential than the Israeli population
- Overall, suggests that main differential is biology-driven



Individualised Risk Factor Conclusions

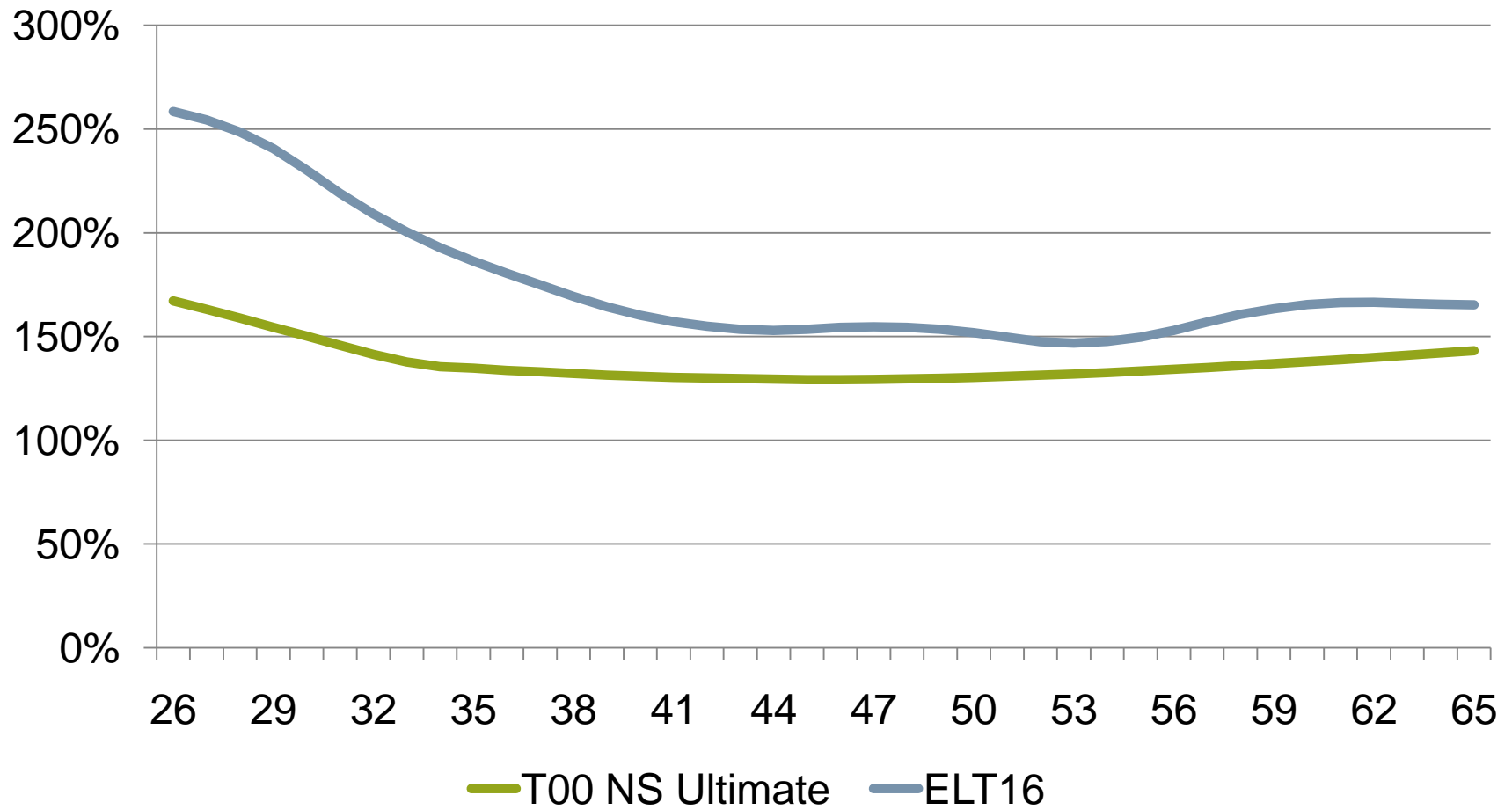
- The behavioral and biological risk factors considered are not on their own sufficient to explain all the differences in male/female mortality;
- Differences in male/female mortality are still present in communities isolated from the stresses of the main populations;
- In all the above there are also environmental influences which cloud the scene, as well as natural variability with small sample sizes.

UK Insured Population – Risk Stratification

UK fully underwritten standard rate term assurance insured populations risk trait stratification:

Yes	Partially	No
Health history Family History Drinking Smoking BMI Hazardous Pursuits	Socio-Economics (via sum assured) Bio-medical Indicators (medicals)	Genetic Tests Marital Status Occupation Ethnicity Exercise Personality

Insured Gender Differentials By Age



Predictive Power of Rating Factors

- Internal Analysis of Term Assurance datablock
- Credible volumes
- Generalised Linear model ran:
 - Modeling number of deaths using Poisson distribution
 - Log-link function
 - Exposure as the offset term
 - Gompertz-Makeham mortality law
- Results compared to annuitant results from Richards and Jones (2004)

Explanatory Power of Rating Factors

Rating Factor	Term Assurance
Age	2145
Smoking Status	320
Gender	100
Duration	95
Amount	40
Channel	10
Joint Life	5

Rating Factor	Annuity
Age	2095
Gender	100
Lifestyle	51
Duration	25
Amount	8
Region	8

Source: Richards and Jones (2004)

Explanatory power is the drop in scaled deviance for the main effect plus one half of drop for related two-way interactions, expressed relative to gender (=100).

Explanatory Power – Health Warnings – Term Assurance Results

- “Amount” Rating Factor is based on banded sum assured and the effect of the banding reduces the variability seen at the lowest sum assured, thus reducing the overall deviance in the model;
- There are correlations in the data, relatively more males at:
 - The higher sums assured;
 - Older ages.



Is the loss of gender as a rating factor a major step backwards in risk assessment?

Practical applicability to life assurance

Need to avoid Indirect Discrimination

- The definition of indirect discrimination:
“where an apparently neutral provision, criterion or practice would put persons of one sex at a particular disadvantage compared with persons of the other sex, unless that provision, criterion or practice is objectively justified by a legitimate aim and the means of achieving that aim are appropriate and necessary;”
- Use of risk factors which correlate closely to proportion of one sex could be illegal.
- Discrimination legislation is always an area of considerable uncertainty until case law has been established.

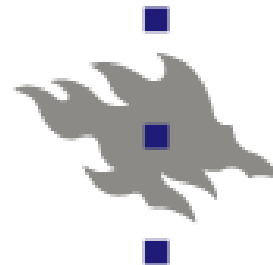
Gender and Medical Underwriting

- Considerations so far have related to “standard rate” lives;
- However, increasing proportions of an insurance book are non-standard lives;
- To what extent can we gender differentiate pricing for non-standard life?

New Rating Factors

- Lack of clear, non-correlated, explanatory factors for gender differentials suggests no significant change in risk assessment immediately;
- Research does suggest use of marital status and Socio-economic profiles in Term Assurance should/would enhance predictive value of models but there may be practical limitations;
- Risk selection could become more refined to try to reduce variance but market direction is more towards making it easier to buy cover, not harder;

“Some of my colleagues at the Department of Sociology in Helsinki wonder whether it is meaningful to study mortality differences. After all, the death rate is the same for everyone; one death per person” (Valkonem 1993)



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Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenters.

The speakers would like to thank all those who helped with the preparation of this presentation but in particular Eli Friedwald and Kaushallya De Alwis. All errors and omissions remain our own.

