University of Leicester

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Overview of multi-state life table methods

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Outline

- Data – cross-sectional v longitudinal
- Longitudinal methods
  - Strengths and limitations
  - Software

Cross-sectional versus longitudinal data

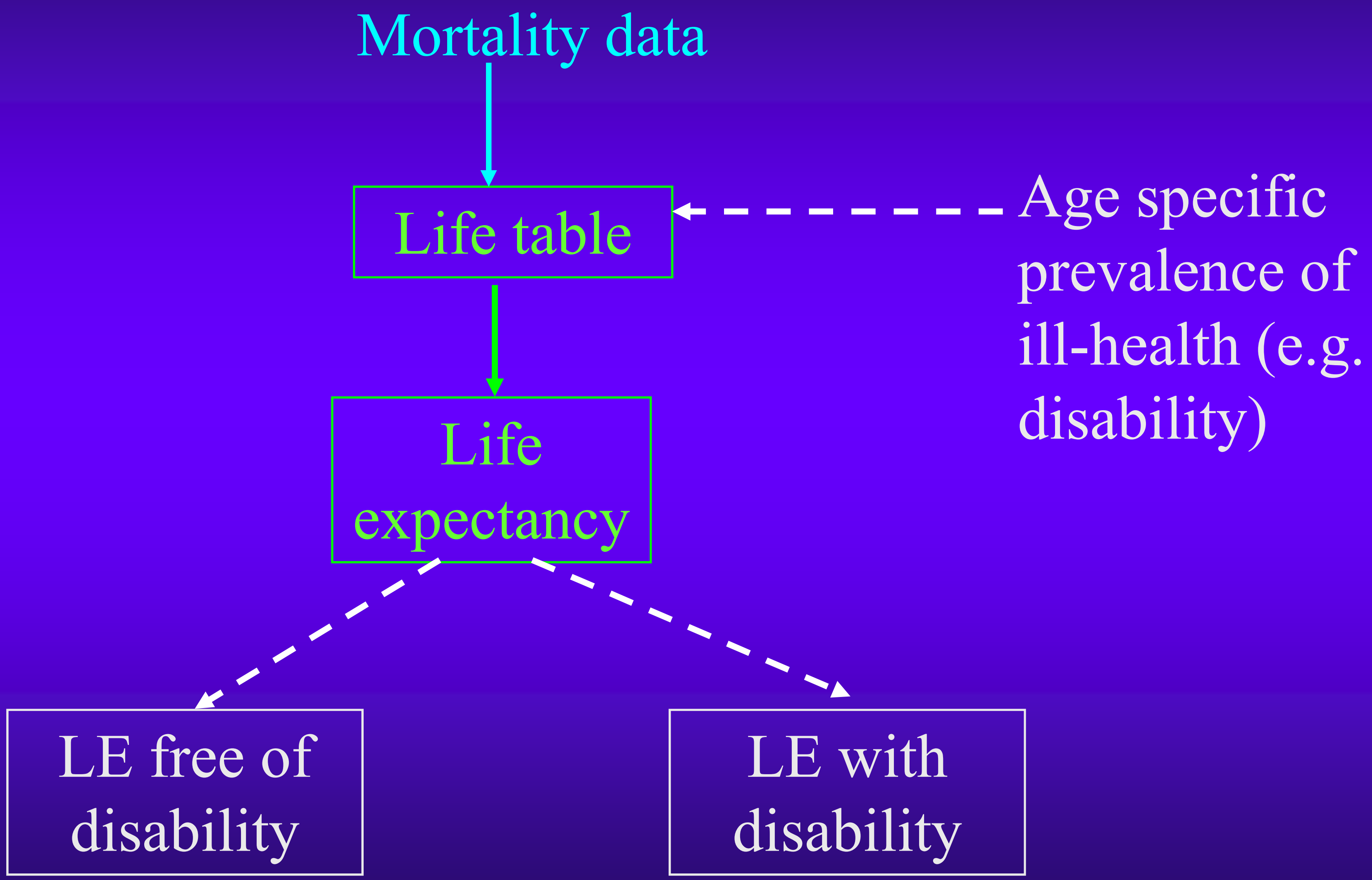
Assumptions

- All methods assume an underlying Markov process
  - probability that a person will leave a state *depends only on the state and the person's age*
  - ignores how long already had state
  - ignores previous history of transitions into and out of state

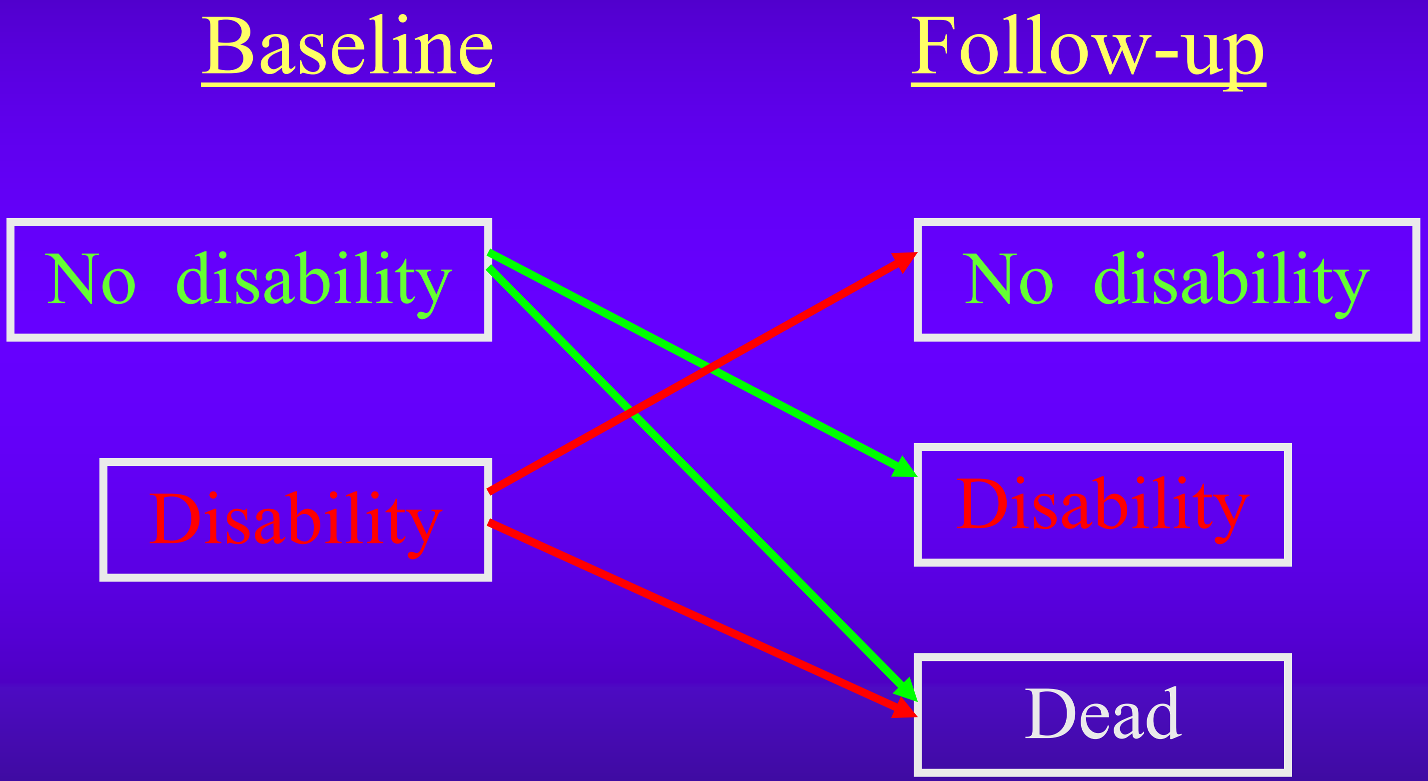
X-sectional v longitudinal data

- The simplest method of calculating a health expectancy is Sullivan's method (Sullivan 1971) with:
  - prevalence of the health state from a cross-sectional survey
  - a standard life table for the same period
- Multi-state life tables require longitudinal data
  - use incidence rates

HE with cross-sectional data



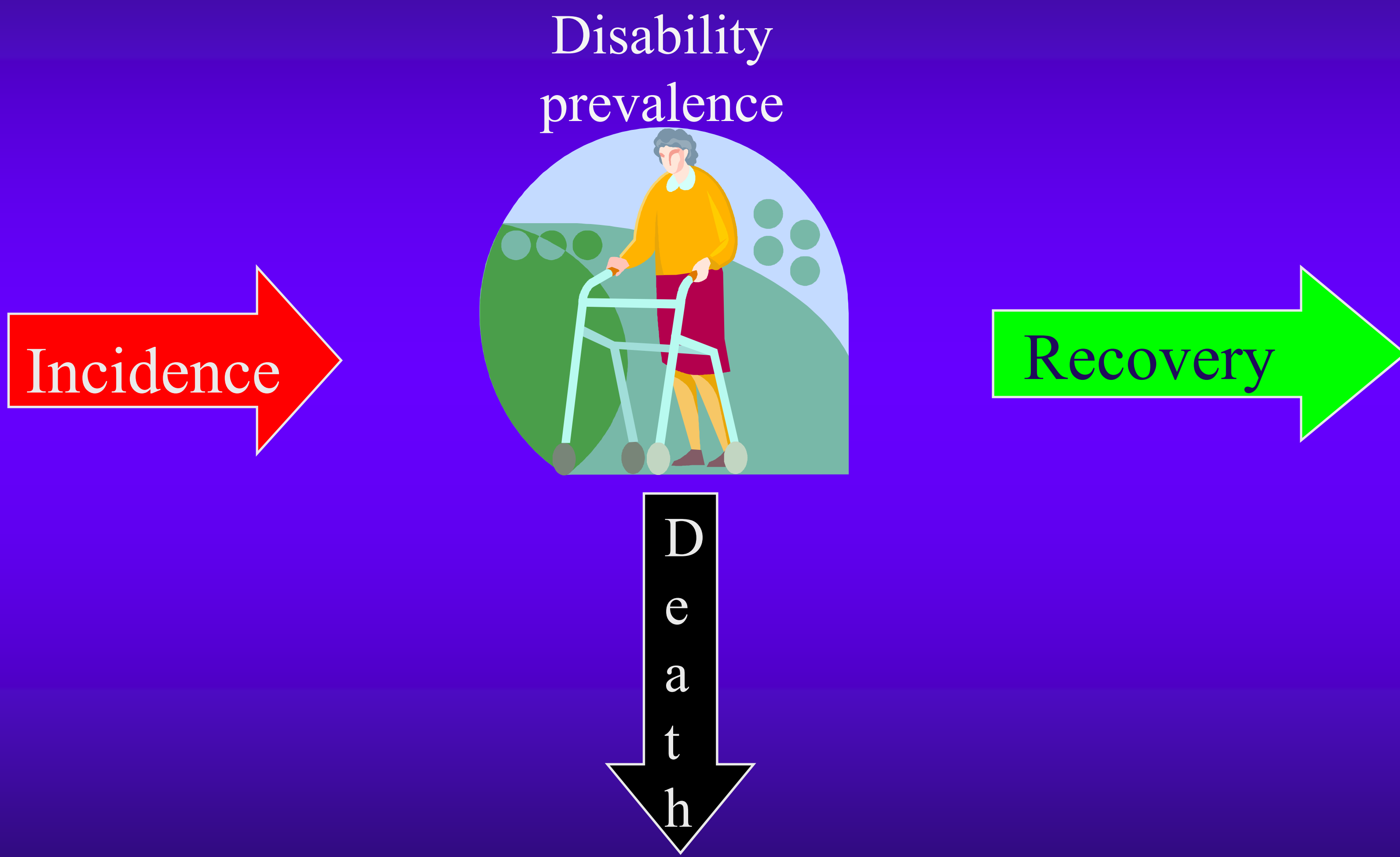
HE with longitudinal data



X-sectional versus longitudinal

- Cross-sectional
  + easiest for trends
  - life tables not available for subgroups
- Longitudinal
  + explicitly estimates incidence and recovery providing better future forecasts
  - cost, attrition

Prevalence v incidence

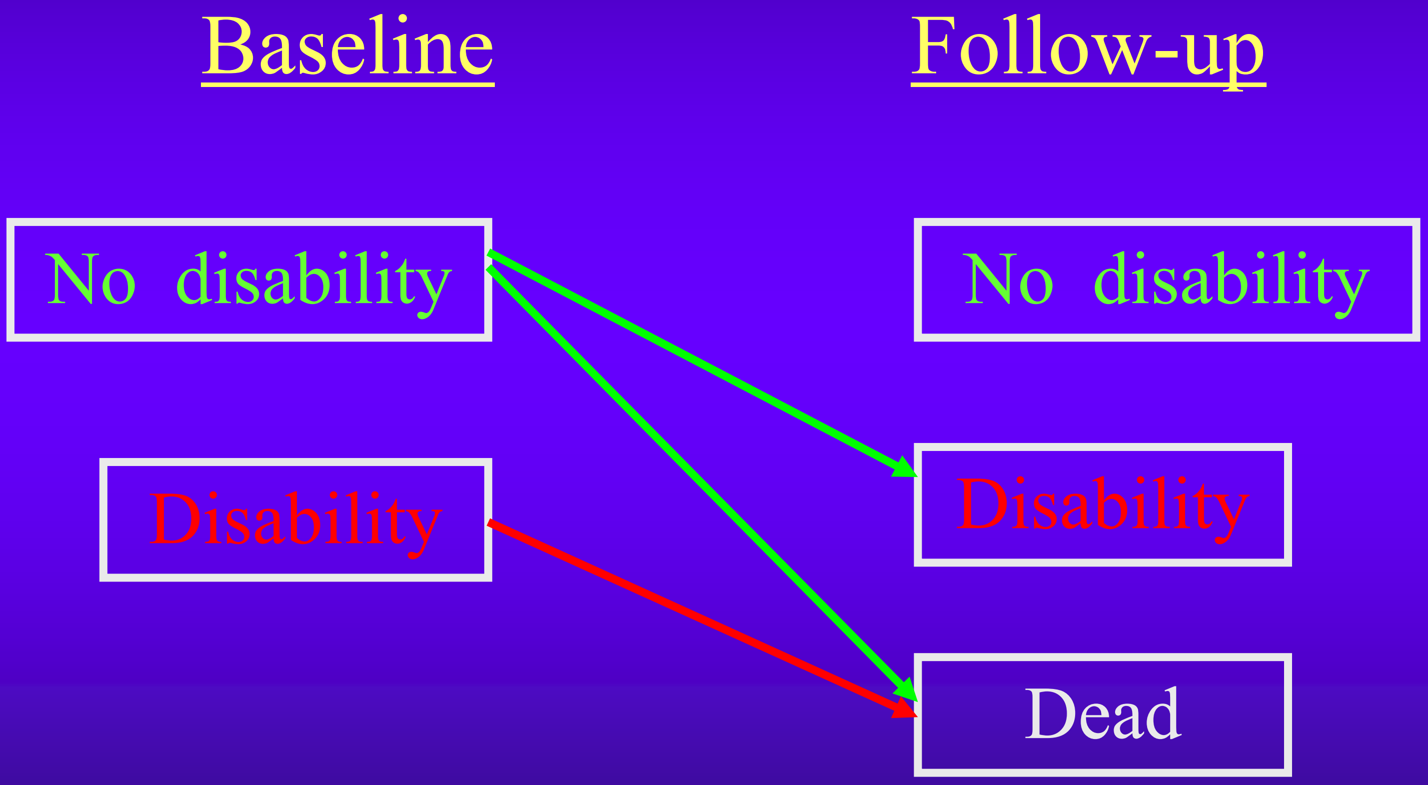


Longitudinal methods

Longitudinal methods

- Multiple decrement
  - Non-reversible processes only
- Multi-state methods
  - Allows for transitions to and from all states
  - One absorbing state (death)
- Microsimulation

Multiple decrement



Multiple decrement methods

- Special case of multi-state methods
- Used for
  - Historically to calculate Active Life Expectancy (Katz, 1983)
  - Mortality by cause
  - Conditions where recovery impossible
    - heart attack, stroke,
    - dementia/cognitive impairment (though scales often blunt so improvements may be observed)

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Multi-state methods

- Multi-state life table developed in 1970s
  - Allows changes in any direction
  - People can experience recurrent events over lifetime
  - Moves do not have to be to adjacent state
  - Can provide estimate of number of transitions over lifetime (but beware)
  - Aids understanding of role of declines and improvements in health

Multi-state methods

- Theoretically use age-specific transfer rates and applies them to hypothetical cohort
  - number of moves from state i to state j between ages x and x+n divided by person-years lived in state i between ages x and x+n
  - refers to moves not people
- Practically use (smoothed) age-specific transition probabilities
  - assumed constant within an age interval

Strengths and limitations

- Strengths
  - More realistic
  - Can incorporate covariates
  - Can use standard statistical software
- Limitations
  - Require longitudinal data for incidence rates
  - Data used not aimed at observing transitions
  - Transitions implicit between waves therefore may underestimate number of transitions as only one assumed between waves

Longitudinal methods

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Microsimulation

- Microsimulation methods
  - Use embedded Markov process to estimate rates (Laditka and Wolf, 1998; Lievre et al, 2003)
  - The elementary transition is modeled as a multinomial logistic thus assuming an individual is in state j at age x_i and state k after a time h then

$$\log[(p_{jk}(x_i, x_i+h)/p_{jj}(x_i, x_i+h)]=a_{jk}(h)+b_{jk}(h)x_i$$

  - Transition matrix between two waves is the product of the elementary matrices (by month)
  - Each person then subjected to given probability of event to simulate healthy life biography

Strengths and limitations

- Strengths
  - Allows for unequal intervals between waves and missing data
  - Relaxes assumption of only one transitions between waves
  - Purpose built software (IMaCH) available
- Limitations
  - Computationally intensive
  - Limited number of covariates

Example

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Educational differences in the dynamics of disability incidence, recovery and mortality: Findings from the MRC Cognitive Function and Ageing Study (MRC CFAS)

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Background This study aims to establish the extent of educational differences in the disability transitions of incidence, recovery and mortality in people aged 65 years and over, whether these can be explained by differentials in disease burden and their relative contribution to educational differences in prevalence and disability-free life expectancy (DFLE).

Methods A stratified random sample of 13 004 participants in five areas in England and Wales were interviewed in 1991–94 and followed up at 2, 6 (one centre only) and 10 years. Two levels of disability were analysed: mobility difficulty and activities of daily living (ADL) disability. We fitted logistic regression models to model educational differences in disability prevalence, incidence, recovery and mortality transitions. DFLE was calculated to assess the combined effect of the dynamic transitions.

Results Those with ≤9 years education had higher ADL and mobility disability prevalence and higher incidence and lower recovery of mobility disability. Differences in disability incidence remained after adjustment for comorbidity. Women with the lowest education had shorter life expectancies (1.7 years less at the age of 65 years) than the most educated and had even shorter DFLE (1.9 years free of ADL disability and 2.8 years free of mobility difficulty at the age of 65 years).

Conclusions Differentials in education continue to contribute to prevalence of disability at ages beyond 65 years in both men and women and independently of diseases. These appear to be driven predominantly by differentials in disability incidence that also compound to produce greater differentials in DFLE between education groups than in total years lived.

Keywords MRC CFAS, socioeconomic factors, disability, old age, self-report, activities of daily living

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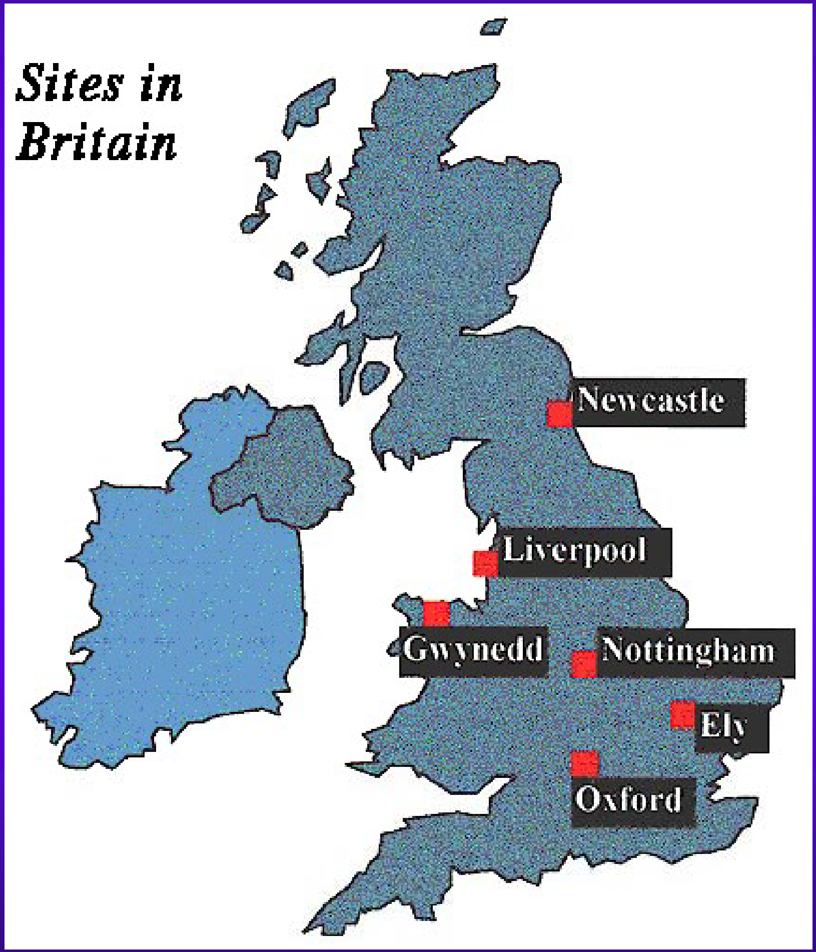
Introduction

The nature of the links between less privileged socio-economic status and health have been extensively studied in middle aged populations, but rather less so in older people, especially in the UK. For mortality, strong links have been demonstrated between socio-economic status and overall survival in older people.[1] Higher prevalence rates of disability (having difficulty undertaking everyday activities) have also been linked to

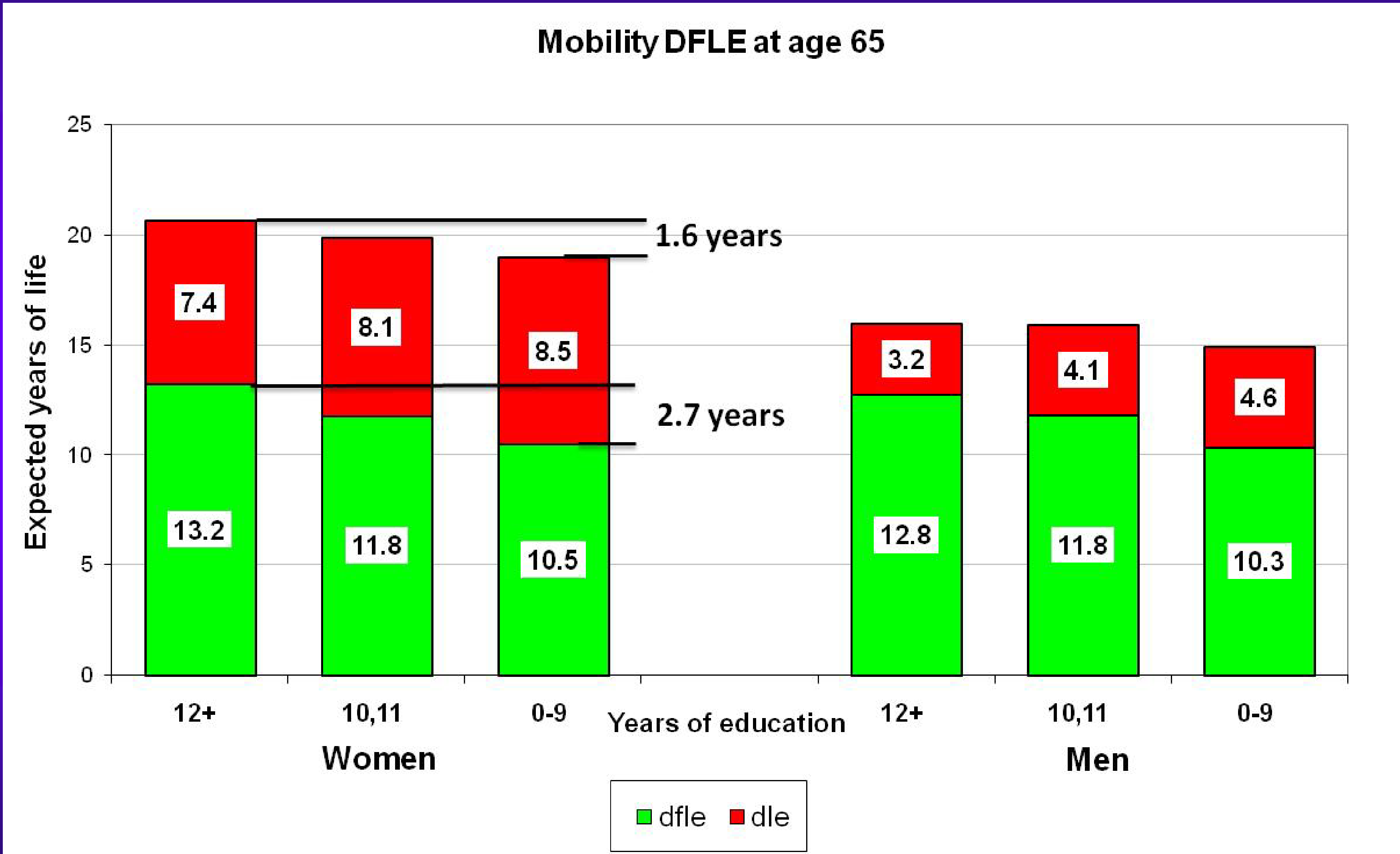
1

MRC CFAS

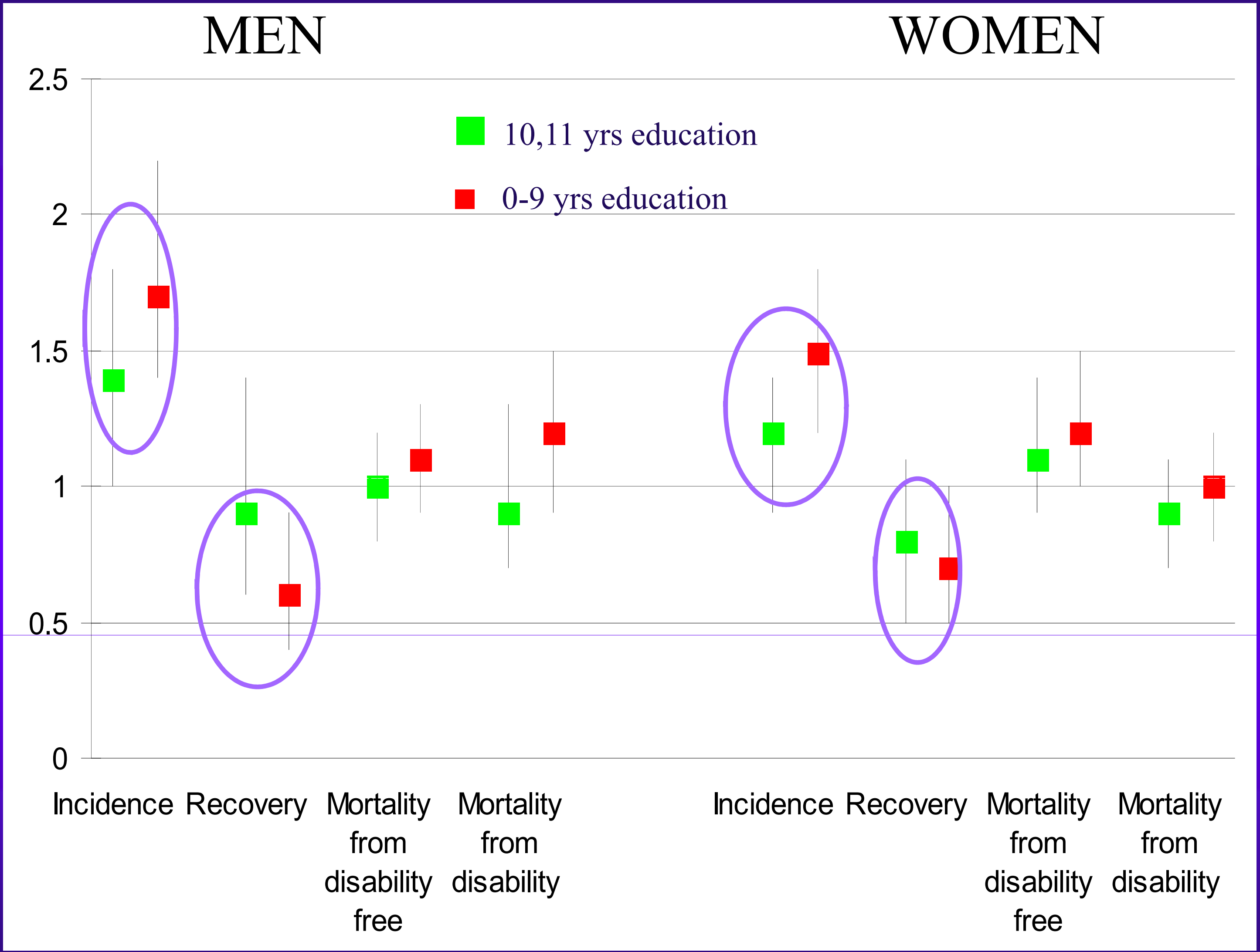
- Five centres
- stratified random sample aged 65+
- includes those in institutions
- 13004 interviewed at baseline in 1991
- 2, 6 (Cambridge only) and 10 year follow-ups
- death information from ONS



Social inequalities at age 65



Mobility disability transitions OR* (95% CI)



*adjusted for age, comorbidity, MMSE

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