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# Estimating healthy life expectancy in the presence of non-ignorable missing data

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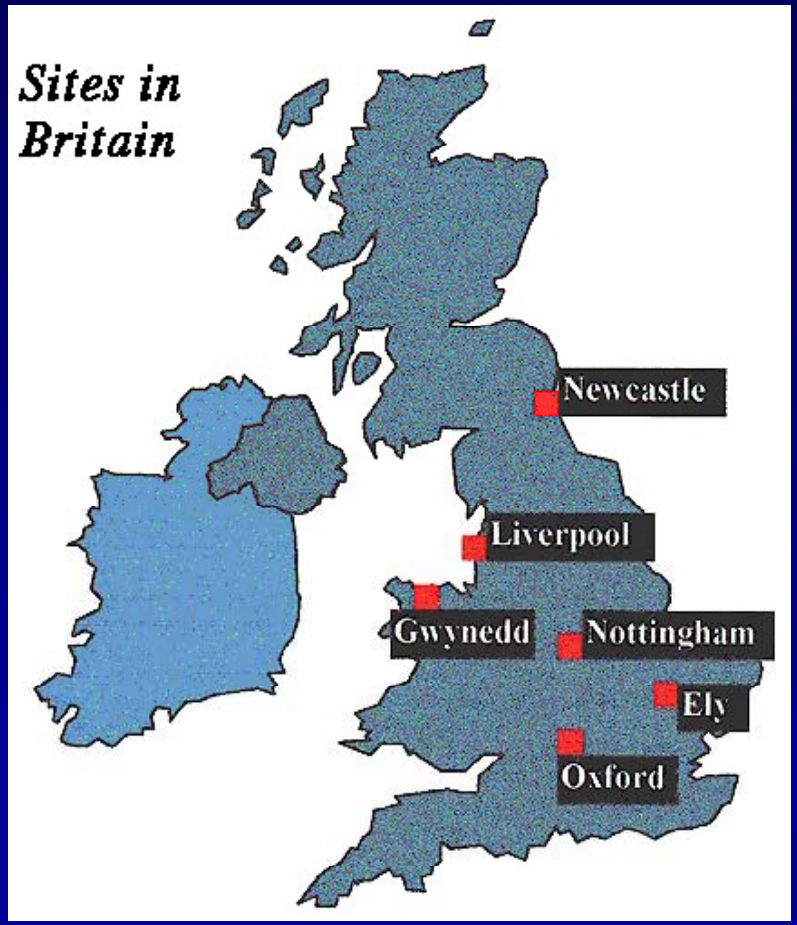
# Application

- Estimate stroke free life expectancy
- Relationship between stroke and risk factors
- Relationship between stroke and death

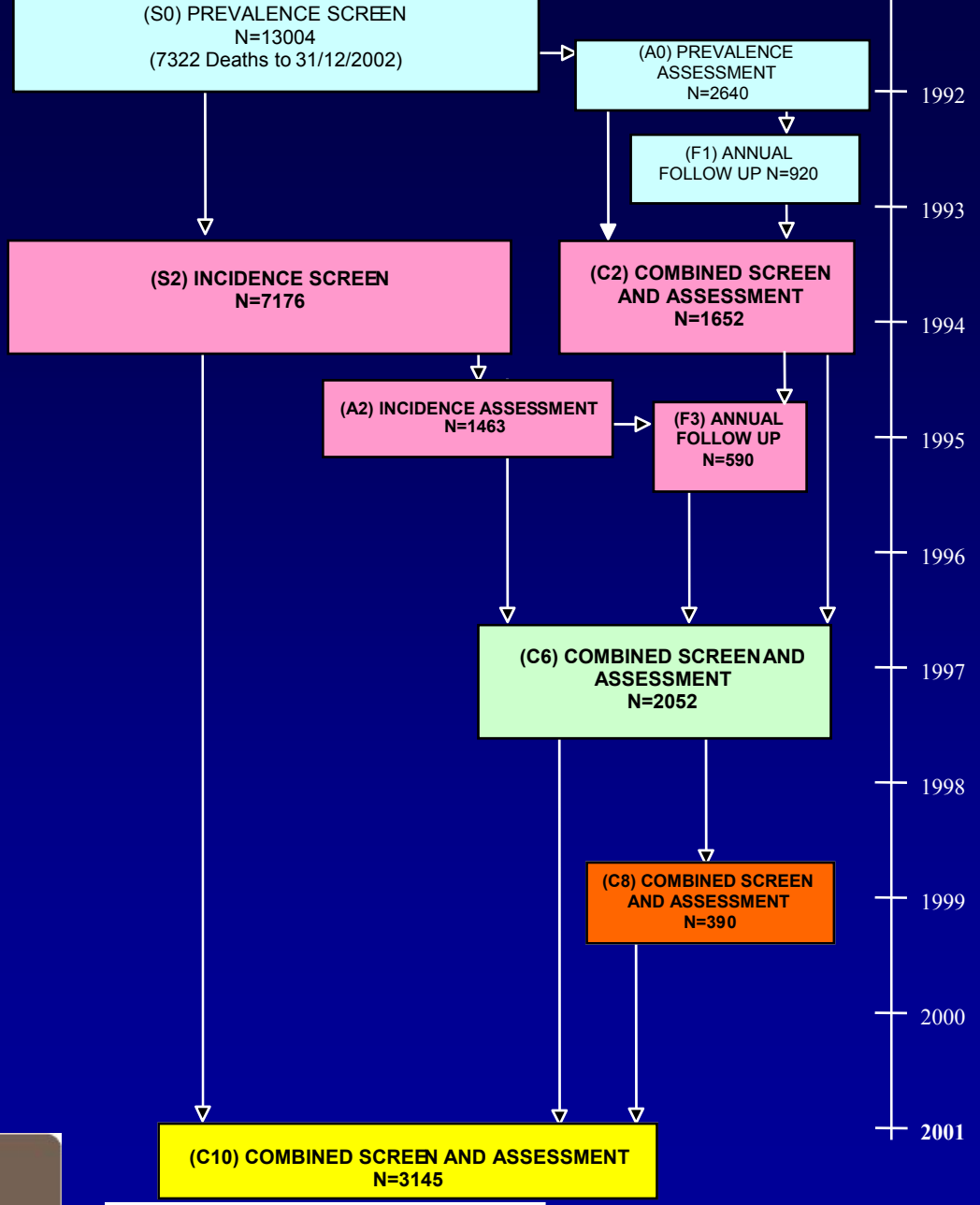
# MRC Cognitive Function and Ageing Study (MRC CFAS)

- Five centres
- Stratified random sample aged 65+
- Includes those in institutions
- Ten years of follow-up
- Death information from ONS



MRC CFAS

STUDY DESIGN

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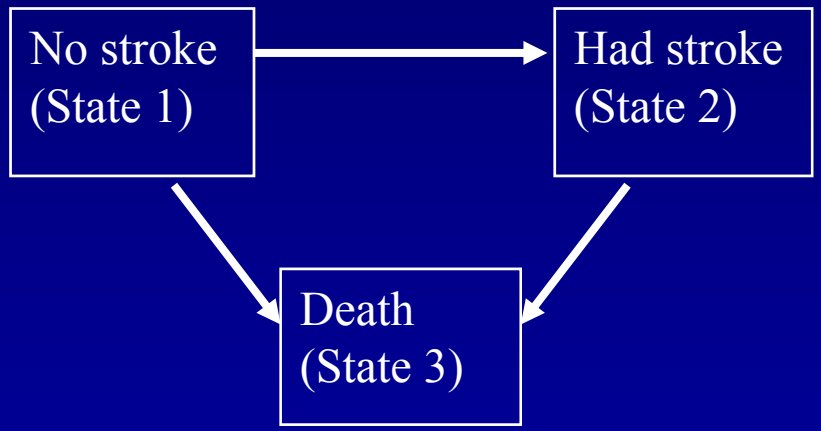
# Multi state models

- Continuous time Markov model
- Irregular observation times



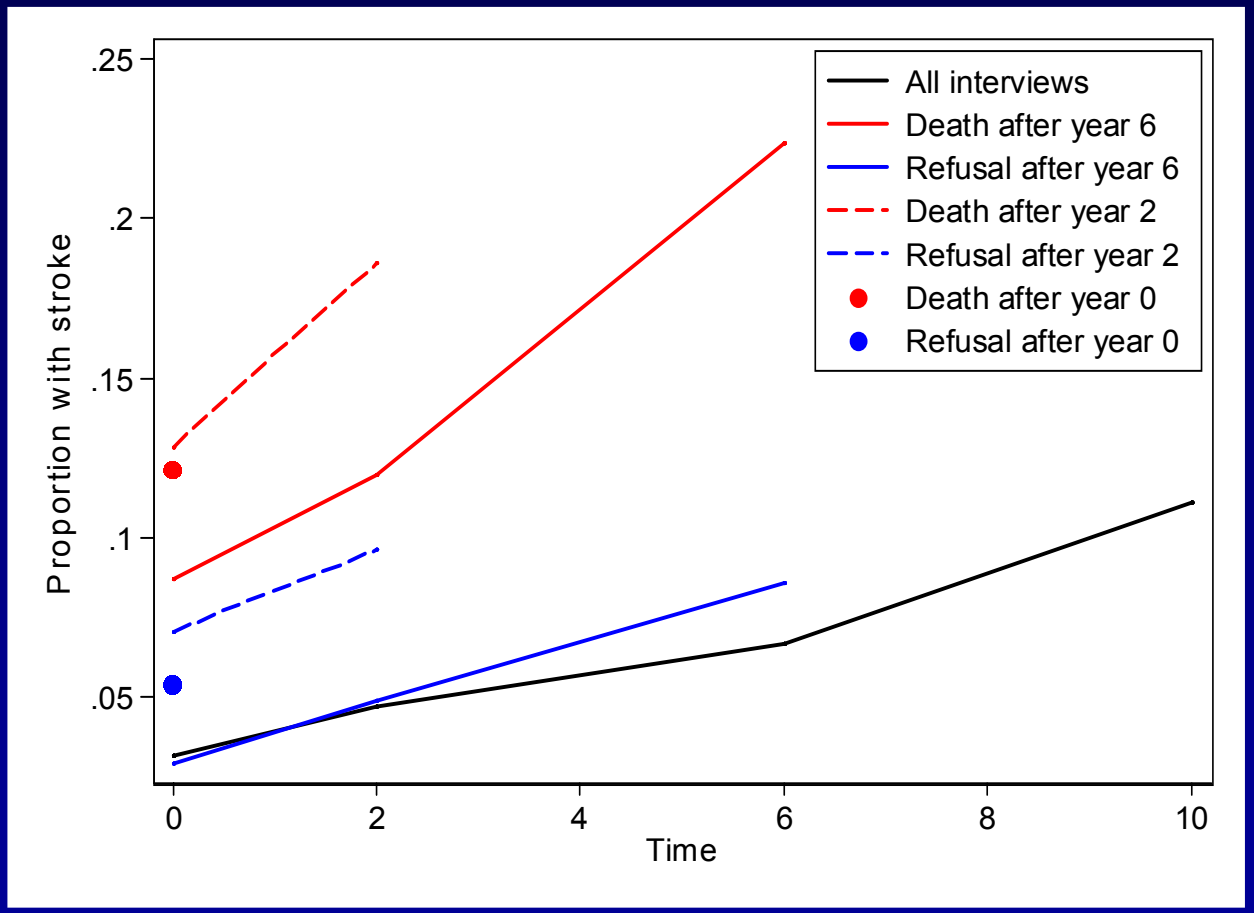
# Difficulties

- Individuals who dropout are not random, but related to the outcome of interest
- Individuals can miss interviews and the return
- They are not even related to things we have previously measured

# Drop out effects in CFAS

| | | Year 2 | | |
|---|---|---|---|---|
| Group: | | Refusers | | |
| Total | | 2520 | | |
| | | OR | 95% C.I. | |
| Age | 65-69 | 1.0 | | |
| | 70-74 | 1.0 | (0.9- | 1.2) |
| | 75-79 | 0.7 | (0.6- | 0.8) |
| | 80+ | 0.7 | (0.6- | 0.8) |
| MMSE | Incomplete | 8.2 | (5.7- | 12.0) |
| | <21 | 7.6 | (6.2- | 9.2) |
| | 22-25 | 3.8 | (3.2- | 4.4) |
| | 26-28 | 1.5 | (1.3- | 1.7) |
| | 29-30 | 1.0 | | |
| Women | | 1.3 | (1.2- | 1.5) |
| Years of education | | 0.8 | (0.7- | 0.9) |

# Response profiles as a function of dropout and death



# Model

- Three state model with missing data
  - e.g. **x**=1,na,2,3
  - Where na is missing
- Replace missing states with feasible states
  - $\Omega(\mathbf{x})=\{(1,1,2,3),(1,2,2,3)\}$
- Likelihood derived from summing over all potential sequences

# Data (Newcastle only)

With missing data

| From state | To state: Censored | Missing | 1 | 2 | 3 |
|---|---|---|---|---|---|
| Missing | 341 | 1209 | 24 | 8 | 546 |
| 1 | 382 | 855 | 2942 | 105 | 837 |
| 2 | 43 | 60 | 0 | 304 | 176 |

Missing data removed

| | | | | |
|---|---|---|---|---|
| 1 | 711 | 2966 | 113 | 1331 |
| 2 | 55 | 0 | 304 | 224 |

# Models

- Complete data model (ignoring missing)
- Missing at random model
- Non-ignorable missing data model

- Age, sex and education are in all models
- Model baseline state, intensities (and probability of observing state)

# Results

| | Complete | MAR | NMAR |
|---|---|---|---|
| Men age 75 | | | |
| Life expectancy without stroke | 6.9 (6.5-7.2) | 7.1 (6.7-7.4) | 7.1 (6.6-7.6) |
| Life expectancy with stroke | 1.3 (1.1-1.5) | 1.3 (1.1-1.6) | 1.4 (1.1-1.8) |
| Total life expectancy | 8.2 (7.9-8.5) | 8.4 (8.1-8.7) | 8.5 (8.0-8.9) |
| Women age 75 | | | |
| Life expectancy without stroke | 8.5 (8.2-8.9) | 9.0 (8.7-9.3) | 8.8 (8.3-9.3) |
| Life expectancy with stroke | 1.6 (1.3-1.8) | 1.6 (1.4-1.8) | 1.8 (1.5-2.2) |
| Total life expectancy | 10.1 (9.8-10.4) | 10.6 (10.3-10.9) | 10.6 (10.2-11.1) |

# Results

- NMAR explicitly models missing data
  - State 1 missing related to age, sex and education
  - State 2 missing related to age, sex and education
  - Missing later states related to previous missing states
- Life expectancy with stroke is underestimated without missing model

# Further extensions

- Can model recovery
- Can change missing model

- Future work on goodness of fit statistics

# MRC Cognitive Function and Ageing Study (MRC CFAS) www.cfas.ac.uk)

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