Bayesian models demonstrate declining trends in leprosy incidence in South India (O146)

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Introduction

- Leprosy known for uneven occurrence
- Birth cohorts undergo long-term exposure to socio-economic & environmental changes and control activities
- Trend analysis should consider spatio-temporal dependence
- Published work on leprosy trends use age, period & cohort analysis
  - Descriptive in nature (Irgens 1980; 1982; Strene et al 1995; Chen et al 2001; Durheim et al 2002)
  - Did not accommodate spatio-temporal dependence [except few (Vasna 2003)]
- Examined leprosy incidence trends from South Indian leprosy vaccine trial data through Bayesian space-time models
South India leprosy vaccine trial

- **Study:** Randomized-placebo controlled field trial
- **Participants:** 171,400 without leprosy or any serious illness; age 1-65 years
- **Setting:** 148 rural units (panchayats) from 264 contiguous villages, a district, South India
- **Follow-up:** 3 surveys (1993-95, 1997-98 & 1999-03) to identify new cases
- **Type of cases:** Mostly PB; small proportion of MB (2%)
Descriptive analysis of leprosy trends in South India leprosy vaccine trial area

- Leprosy incidence declined steeply in ‘vaccinated’ cohort compared to ‘placebo’ or ‘unvaccinated’ cohorts
- Incidence higher among older age cohorts and among men
- Increase in mean age at onset
- No increase in incidence of MB
- Stable (~ 4%) visible disability among new cases
Space-time analysis

- Used Bayesian approach
- Space: 148 rural units (*panchayats*) of the trial area
- Time:
  - Cohorts
    - Cross-classified cases into 20 age groups (1-4, 5-9, ..., 90-94, 95-99)
    - Defined 20 rolling cohorts, & labelled them using mid-point
  - Period
    - Mid-point of follow-up surveys (calendar time) [1994, 1997 & 2001]
Bayesian methods: Prior

- Leprosy incidence as 40 per 10,000 (based on Poisson distribution)
- Gamma priors
- Markov Chain Monte Carlo (MCMC) simulation
Bayesian methods: Data

- Space-cohort model
  - Aggregated over 20 birth cohorts
- Space-period model
  - Aggregated over three periods
- Adjusted for age
- Used interaction term: space*cohort
- Used Deviance information criterion (DIC) for assessment of model
Bayesian methods: Posterior

• Obtained posterior distributions using Gibbs sampling in WinBUGS
  – Fitted models with (1,000,000 iterations) & without (50,000 iterations) interactions

• Calculated effects as median relative risks (RR) & 95% credibility intervals (CI)
Cohort effect on leprosy incidence
South India leprosy vaccine trial setting, 1991-2002

- Higher risk for older cohorts (<1957)
  - Range of RR=1.1 to 6.4
- Lower risk for younger cohorts
  - Range of RR=0.87 to 0.42
  - 58% reduced risk for persons born > 1997
## Period effect on leprosy incidence

South India leprosy vaccine trial setting, 1991-2002

<table>
<thead>
<tr>
<th>Mid-point of follow-up period</th>
<th>RR (95% CI)</th>
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<tbody>
<tr>
<td>May, 1994</td>
<td>1.31 (1.23-1.40)</td>
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<tr>
<td>November, 1997</td>
<td>1.04 (0.99-1.09)</td>
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<tr>
<td>March, 2001</td>
<td><strong>0.74 (0.69-0.79)</strong></td>
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</tbody>
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Spatial effect on leprosy incidence
South India leprosy vaccine trial setting, 1991-2002

13 *panchayats* high risk
- 50% excess risk for 7 areas
- 5 shared common boundaries (North-West)
- 35% belonged to economically backward (range: 6-65%)
- Population density 2084/km² (3-5 times > district)
Conclusions

• Increased leprosy risk for older cohorts
  – Suggestive of evidence for endogenous activation

• Reduced leprosy risk over period
  – Correlated with interventions (Mono or multi-drug therapy & vaccination)

• Endemicity levels declined considerably
  – Persistence of pockets with high population density & poor socio-economic status
Recommendations

• Reactivation is possible
  ✓Hence, surveillance is the key

• Identification of clusters & their characteristics
  ✓Plan focused strategies for small areas within low-endemic regions
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