Spatiotemporal epidemiology of child HIV/AIDS mortality for large zero-inflated data in Agincourt from 2000 to 2005.

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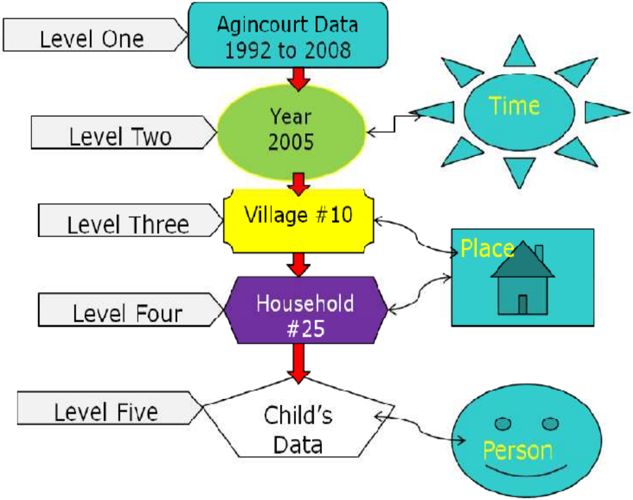
Background

- About 922 million people (11 % of the world's population) reside in Africa
- More than 25 million people are living with HIV/AIDS
- More than a fifth (5.5 million) of these people are from South Africa
- National antenatal clinic prevalence of 30.2%, recent statistics of about 17%
- Highest absolute number of HIV infected persons in the world
- Disease control more difficult due to opportunistic infections and core infection with TB

Public Health and Spatial-epidemiology

- Identification and quantification of patterns in disease occurrence leads to increased understanding and control of diseases
- Public health policy-makers rely on data for allocation of resources and interventions. Successful modeling is only an end product of good data.
- In epidemiology, person, place and time matter in relation to identification of risk factors; yet little has so far been done to link all three.
- Spatial epidemiology began with the recognition that maps can be useful tools for illuminating causes of disease and areas of high risk.

Hierarchical data model



Time and space correlation in data

- The data are spatiotemporal data (correlated in time and space).
- The data are enormous thus conventional statistical modelling techniques cannot fully extract the wealth of information locked within them
- Statistical methods applied to spatial data which have spatial autocorrelation often underestimate the standard error and thus the statistical significance is overestimated
- The other complexity is that of too many zeros(more than 95% are zeros) on a binary outcome

Geoadditive Cox regression model

Geoadditive Cox regression hazard model

$$\lambda_i(t; x_i, s_i, v_i) = \lambda_0(t) exp(\gamma_i(t)) = exp(f_0(t) + \gamma_i(t)) = exp(\eta_i(t))$$

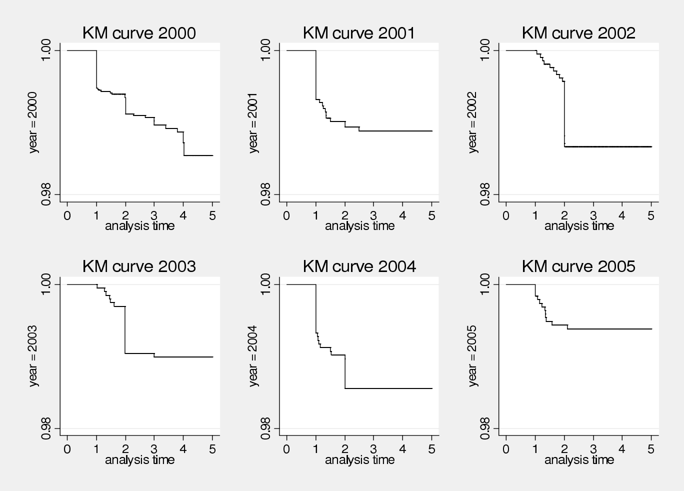
$$\eta_i(t) = f_0(t) + \sum_{j=1}^{p} f_j(x_{ij}) + f_{spat}(s_i) + v_i'\gamma + b_{s_i}$$

Where $f_0(t) = log(\lambda_0(t))$ is the log-baseline effect, $f_j(x_{ij})$ are non-linear effects,$v_i'\gamma$ are the linear effects, $f_{spat}(s_i)$ is the structured spatial effect of the spatial covariance s (where s_i is the house where the child comes from) and b_{s_i} being the unstructured spatial effect.

Descriptive Statistics

- The data used were for 16,844 children aged 1 to 5 years residing in Agincourt HDSS from 2000 to 2005
- Geo-location data were available from 8,863 households
- A total 187 deaths were HIV /AIDS (including HIV/Tuberculosis)which is 1.11%
- A total of 59,448.15 person years yielding a 1 to 5 years mortality rate (1-4MR) of 3.15 deaths per 1000 person years
- Over-dispersion parameter estimate $\sigma = 1.79$(sd=1.87)
- Zero-Inflation parameter estimate $\theta = 0.077$(sd=0.062)
- Hence we might have an unstable model if we ignore over-dispersion and zero-inflation

Kaplan Meier curves for 2000 to 2005



Results

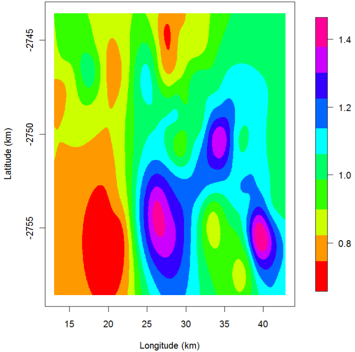
Multivariate analysis showed nine predictors of child HIV/TB mortality;

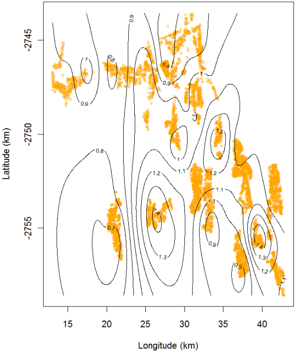
- **Child Gender**: Boys were 36% more likely to die;1.36 95%CI [1.08;1.88]
- **Nationality of Child**: South African children had lower risk compared kids of Mozambican origin;0.51, 95%CI[0.24,0.96]
- **Mother's death**, AIDS orphans were 3 times at greater risk of death; 2.93, 95%CI[1.29;6.93]
- **Gender of household head**: Male headed HH had a protective effect; 0.58,95%CI[0.45;0.75]

Results continued..

- **Year of death**: Higher risk in 2002 vs 2000; 2.02,95%CI[1.13,4.00]
- **Antenatal clinic visits**: Increasing protective effect; 0.84,95%CI[0.81;0.89]
- **Socio-economic status**: Least poor households were 62% at lower risk; 0.38,95% CI[0.24;0.61]
- **Birth order position**: Later births protective 27% lower risk ; 0.73, 95%CI[0.58;0.89]
- **Multiple household of deaths**: Double the risk; 2.00,95%CI[1.12;3.33]

Posterior Hazard Rate and Contour maps





Concluding remarks

Conclusions

- Child survival is dependent on the survival of the mother, hence the need strengthen antiretroviral treatment
- Reducing mother-to-child transmission by strengthening PMTCT
- This study supports the South African government's revised prevention of mother to child transmission (PMTCT) policy effected on 1 April 2010 allowing women with CD4-350 to be on ARVs vs CD4-200 NA
- Rural South African populations are increasingly utilizing the available health facilities suggesting a shift from traditional medicine reliance.

Conclusions continued

- Risk factor analysis accounting for person, place and time enables policy makers to target interventions where there is a need
- Statistical techniques applied linked the person, place and time patterns of HIV-TB mortality in a Health Socio Demographic site
- Bayesian geo-additive semi-parametric zero inflated spatiotemporal models can be utilized to detect patterns within populations which otherwise would have been obscured.

Acknowledgements

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