Joint spatial modeling of gender-specific cancer data at subregional level

Verena Jürgens[1], Joachim Kieschke[2], Antje Timmer[1]

[1]University of Oldenburg, Department of Health Services Research, Division of Epidemiology & Biometry, Oldenburg, Germany

[2]Epidemiological Cancer Registry of Lower Saxony (EKN), Oldenburg, Germany

Introduction

Reference area

- Lower Saxony (German state):
  - ∼47 624km^2
  - ∼8 million inhabitants
  - Division in 384 RMUs (regional monitoring units, see Fig. 1)

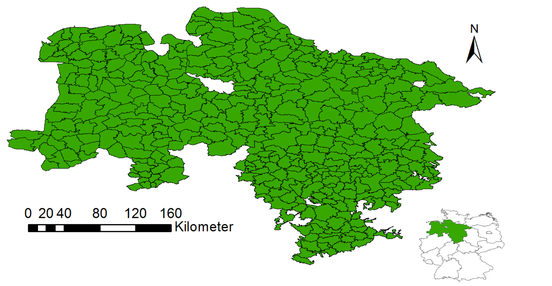

Figure 1: Lower Saxony, division in RMUs.

Conditions studied

- Breast cancer (ICD-10 C50)
  - Most common cancer diagnosed in females in Lower Saxony (32.1% of all cancers diagnosed, in 2011)[1]
  - Among others, reproductive and genetic factors increase the risk
  - Mammography screening started in 2005
- Prostate cancer (ICD-10 C61)
  - Most common cancer diagnosed in males in Lower Saxony (28%, in 2011)
  - Hormonal and genetic factors increase the risk, but risk factors in general not well studied
  - High incidence might be due to PSA (prostate-specific antigen) screening
- Similarities between breast and prostate cancer and common risk factors have been reported (e.g. genetic mutations) [2]
- Implementation and access to screening are potential determinants of the spatial and temporal distributions [3, 4]

Data source

- Age-specific (5-year age groups) female breast and male prostate cancer cases at RMU level during 2008–2012
- Age-specific population data at RMU level during 2008–2012
- Shapefiles, defining the neighbouring structure of the RMUs

Objective

- Analyse potential common spatial pattern for gender-specific (female breast and male prostate) cancer risk by joint spatial modeling of gender-specific cancer in Lower Saxony during 2008–2012

Methods

- Indirect age-standardization using overall population of Lower Saxony as a reference
- Jointly model disease-specific incidence in space by *shared-component model* [5, 6, 7]
  - Model formulation covers disease-specific spatially structured and unstructured random effects and a shared component measuring the geographical association between the two diseases
  - Bayesian spatial Poisson regression model

$$y_{ij} \sim Pois(E_{ij}\theta_{ij})$$

$$log(\theta_{i1}) = \alpha_1 + \varphi_{i1} + \phi_i\delta$$

$$log(\theta_{i2}) = \alpha_2 + \varphi_{i2} + \frac{\phi_i}{\delta}$$

where y_{ij} are the observed number of cancer cases in the i^{th} RMU (i=1,...,384) for the j^{th} disease (j=1 for prostate and j=2 for breast cancer), E_{ij} the corresponding expected cases, θ_{ij} the relative risk, α_j the disease-specific intercept, φ_{ij} the convolution prior [8] (the sum of a disease-specific spatially structured and an unstructured random effect), ϕ_i the spatial shared-component and δ a scaling factor.

- Spatial random effects were assumed to follow a conditional autoregressive prior distribution
- Model formulation and fitting based on Markov chain Monte Carlo was done in WinBUGS (Imperial College and MRC, London, UK)

Results

- Minor shared spatial pattern but considerable amount of spatial breast cancer incidence variation explained by shared component
- Greater contribution of shared component to breast cancer incidence (indicated by relative risk ratio estimate <1)
- Disease-specific and shared variability higher for breast cancer
- Information of urbanization level (defined by population density) did not improve model performance (indicated by the Deviance Information Criterion)

Outlook

- Refined study of areas showing common risk distribution
- Consideration of information on hospital density or screening services/accessibility as covariates
- Joint modeling at larger geographical scale such as country level

References

[1] Epidemiologisches Krebsregister Niedersachsen, Registerstelle. Krebs in Niedersachsen 2011. *Report* 2014.

[2] Mandal R, St-Hilare S, Kie J, Derryberry D. Spatial trends of breast and prostate cancers in the United States between 2000 and 2005. *IJHG* 2009; **8**(53).

[3] Brantley-Sieders DM, Fan KH, Deming-Halverson SL, Shyr Y, Cook RS. Local breast cancer spatial patterning: A tool for community health resource allocation to address local disparities in breast cancer mortality. *PLoS ONE* 2012; **7**(9):e45238.

[4] Rogerson P, Sinha G, Han D. Recent changes in the spatial pattern of prostate cancer in the U.S. *Am J Prev Med* 2006; **30 (2 Suppl)**:50–59.

[5] Knorr-Held L, Best NG. A shared component model for detecting joint and selective clustering of two diseases. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 2001; **164**(1):73–85.

[6] Richardson S, Abellan JJ, Best N. Bayesian spatio-temporal analysis of joint patterns of male and female lung cancer risks in Yorkshire (UK). *Statistical methods in medical research* 2006; **15**(4):385–407.

[7] Onicescu G, Hill E, Lawson A, Korte J, Gillespie M. Joint disease mapping of cervical and male oropharyngeal cancer incidence in blacks and whites in South Carolina. *Spatial and Spatio-temporal Epidemiology* 2010; **1**(2–3):133–41.

[8] Besag J, York J, Mollié A. Bayesian image restoration, with two applications in spatial statistics. *Annals of the Institute of Statistical Mathematics* 1991; **43**(1):1–20.

Department of Health Services Research, University of Oldenburg, Ammerländer Heerstraße 140, 26129 Oldenburg, Germany,

T +49 441 798 2745, www.uni-oldenburg.de/epidemiologie

verena.juergens@uni-oldenburg.de