SKDE

Geographical study of stroke incidence and mortality rate using Bayesian analysis

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Objectives

To investigate :

- geographical variation in stroke incidence and mortality rates
- socioeconomical variation in stroke mortality rates

Methods

- Multi-level Bayesian models
- Spatial model to investigate geographical variation
- Cox proportional hazards model for survival analysis

Results

- Minor geographical variation in stroke incidence rates
- No geographical variation in stroke mortality rates
- Socioeconomical variation- patients with higher income and higher education levels are more likely to survive stroke

Introduction

Stroke is an acute condition that requires immediate attention. Moreover, it has high morbidity which means that stroke patients put a heavy burden on the healthcare system. Studying geographical and socioeconomical effects on stroke patients enables us to build a healthcare system that provides equal and high quality services.

Data

- Stroke patients from Norwegian stroke registry (NHR) 2014-2018
- Supplemented with additional patients from Norwegian patient registry (NPR) with stroke diagnosis ICD-10 codes I61, I63, I64
- Statistics Norway (SSB)
- Cause of death registry (DÅR)
- Ages 45+
- Individual data

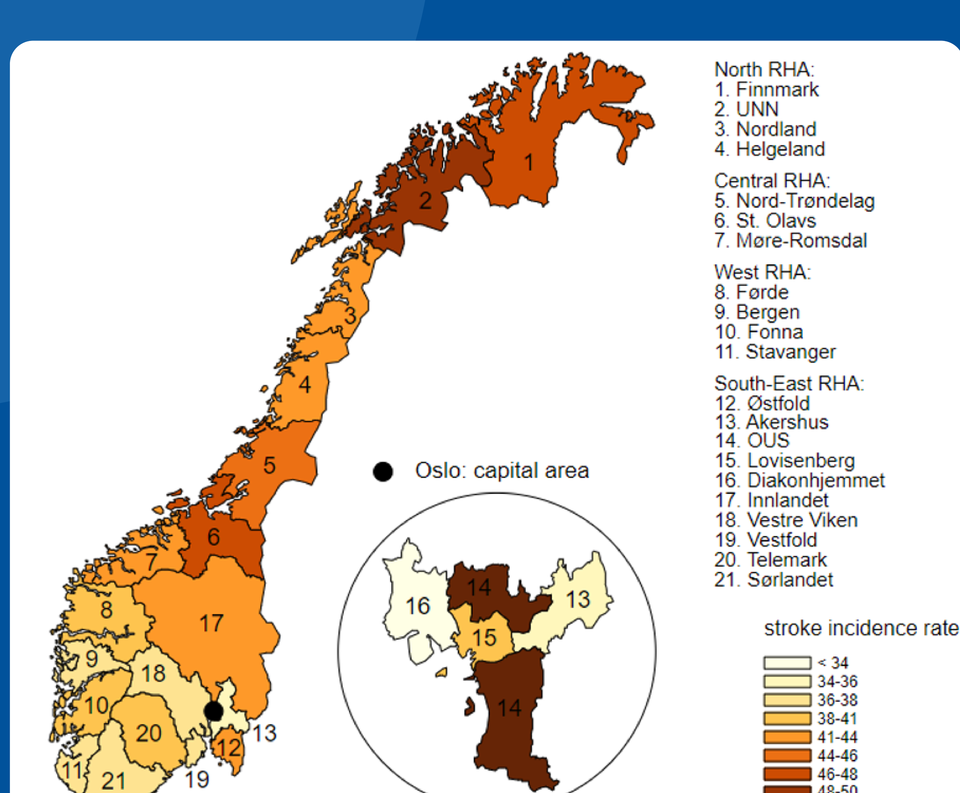

Figure 1: Age- and gender-adjusted stroke incidence rate.

The annual national average stroke incidence rate is 40 per 10 000 population.

Hospital referral area OUS has the highest incidence rate at 52 per 10 000 population. Hospital referral area Diakonhjemmet has the lowest incidence rate at 34 per 10 000 population.

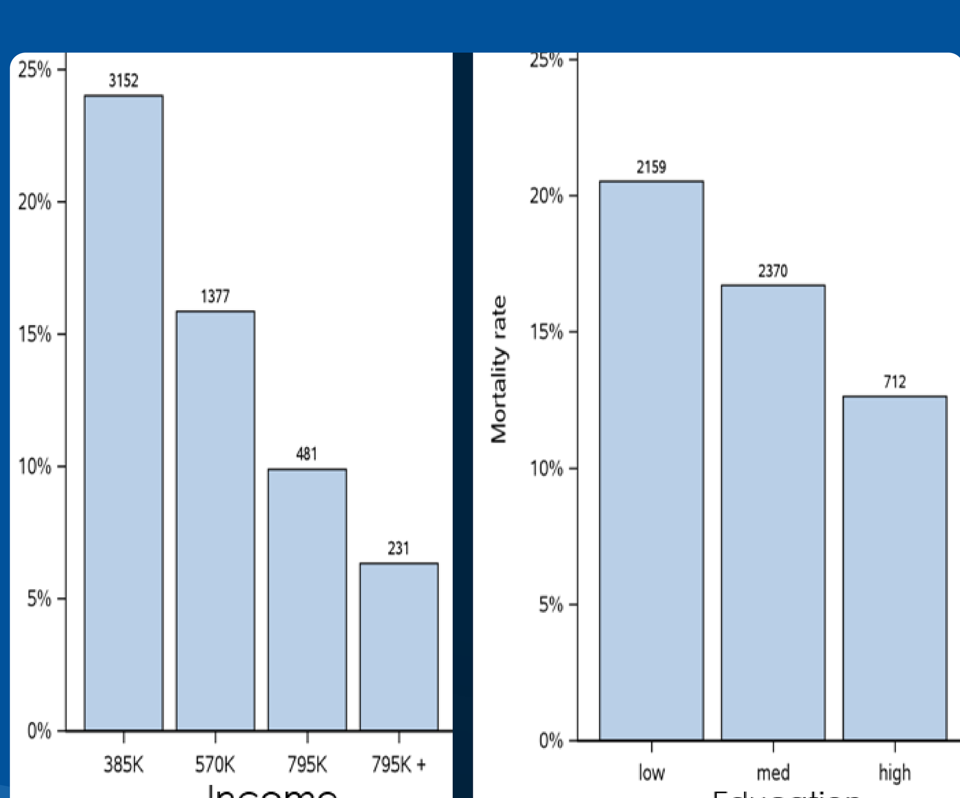

Figure 2: Mortality rate by income levels.

After-tax household income in 4 levels: up to 385 000 NOK, 385 001 – 570 000 NOK, 570 001 – 795 000 NOK, and 795 001 NOK and above.

Education levels:
low = grades 1-10 (obligatory),
medium = up to high school,
high = bachelors and above.

Methods

While stroke incidence and mortality have been studied extensively, there have been few studies that use Bayesian statistics as analytical tool. It constructs multi-level models and gives us probability distribution for the parameters of interest.

Multi-level Bayesian spatial model was used to investigate geographical variation of stroke incidence and mortality rates.

Bayesian Cox proportional hazards model was used to investigate risk factors of stroke mortality.

Key findings

Stroke incidence

The Bayesian spatial model gives us the effects of geographical areas and the 95% credible intervals (CI) from the resulting probability distributions. CI that cover 0 indicates that there is no effect.

Figure 3 shows that referral area 14 (OUS) has significantly higher incidence rate. All other areas have weak or no effects. We therefore conclude that overall there is minor geographical variation in stroke incidence rates.

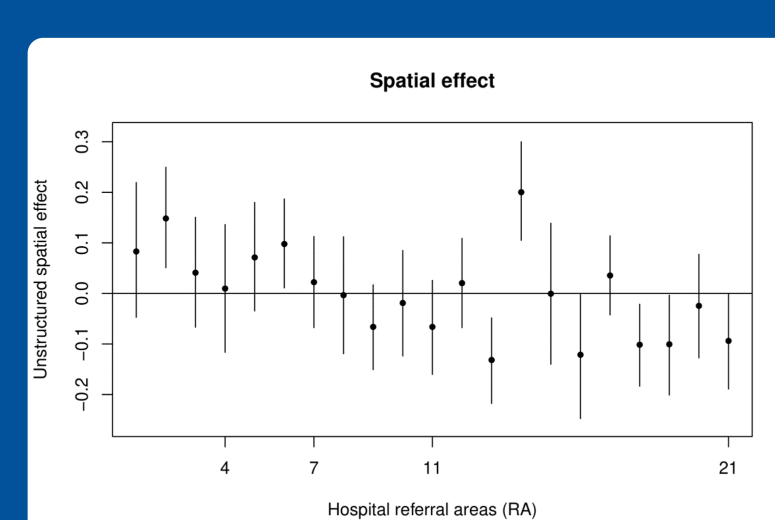

Figure 3: Spatial effects on stroke incidence.

The dots represent the mean of resulting probability, and the line segments represent the 95% credible intervals.

The discription of the areas are given in figure 1.

Stroke mortality

The Bayesian survival models give us the effects of geographical areas and the effects of the risk factors.

Figure 4 shows that there is no geographical variation in mortality rate.
Figure 5 shows the effects of risk factors in the model. Patients in the older age groups have higher mortality rates. Ischemic stroke (block) has less effect on mortality than hemorrhagic stroke. Patients with higher education or higher income levels have lower mortality.

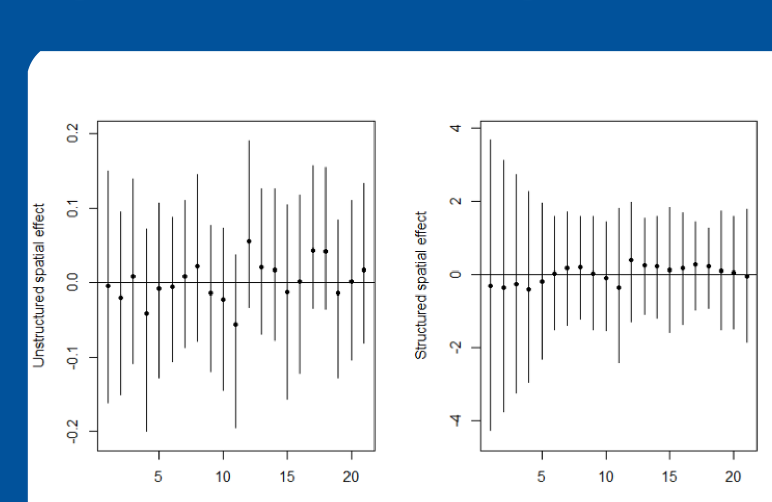

Figure 4: Spatial effects on stroke mortality.

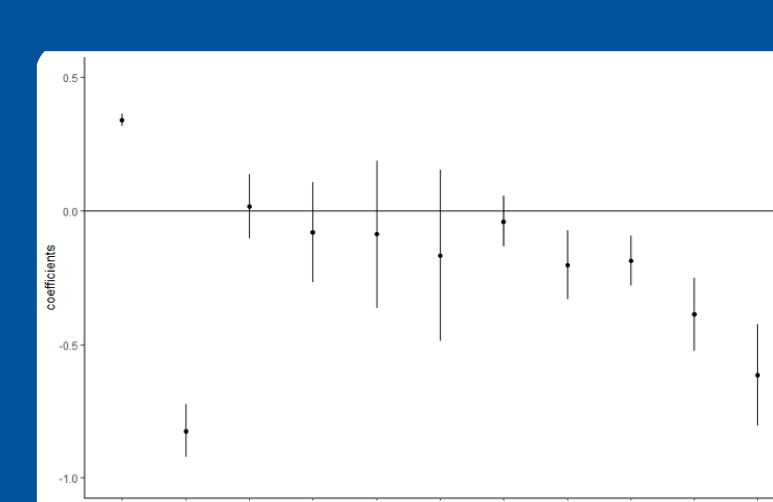

Figure 5: Effects of other potential risk factors of stroke mortality.

Future studies

Sub-dividing the referral areas to smaller regions, for example municipalities, to see if there are some that have incidence or mortality rates different from other municipalities.

Including other risk factors, such as comorbidity, stroke severity, timeliness of treatment and type of treatment, to better understand risk factors of stroke mortality.