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Geographical variation in a fatal outcome of acute myocardial infarction and association with contact to a general practitioner

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ABSTRACT

Background: Geographical variation in incidence and mortality of acute myocardial infarction (AMI) is present in Denmark. We aimed at examining the association between contact to a general practitioner (GP) the year before AMI and a fatal outcome of AMI.
Methods: Register-based data and individual-level addresses including 69,608 individuals with AMI in 2006-2011. A Bayesian hierarchical logistic regression model was used to examine the association.
Results: A fatal outcome of AMI was seen among 12.0% (78%) of individuals with (without) contact to a GP the year before AMI. A significant association was estimated.
Conclusions: A fatal outcome of AMI was significantly associated with contact to a GP. A high population to GP ratio and long distance to GP could not explain the increased odds of a fatal outcome of AMI for individuals with no contact to a GP.

1. Introduction

Cardiovascular disease (CVD) is a major cause of death in Denmark and worldwide (Murray et al., 2015). Acute myocardial infarction (AMI) is commonly referred to as a heart attack and is the most serious coronary heart disease. It is an acute disease as immediate medical treatment to restore coronary blood flow with either acute primary percutaneous coronary intervention (PCI) or initiation of antithrombotic pharmacotherapy and care in dedicated coronary care units is needed to reduce heart damage and death. The incidence rate of AMI was 196 and 357 per 100,000 person-years in women and men in Denmark in 2011, respectively (Kock et al, 2014). The mortality rate of AMI was 52 and 71 per 100,000 person-years in women and men in Denmark in 2011, respectively (Kock et al, 2014). The incidence and mortality of CVD including AMI are continuously decreasing in Denmark and most industrialized countries (Koch et al., 2014; Murray et al., 2015; Beaglehole, 1999) due to increased focus on prevention and strategies to reduce risk factors. However, health varies geographically across and within countries (Jones and Moon, 1987; Howard et al., 2009; Lloyd-Jones et al., 2009; Shiue and Hristova, 2014; Rodrigues et al., 2015).

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In Denmark, spatial patterns in CVD have been shown at a regional level (Koch et al., 2014) and Kjærulff et al. demonstrated spatial clustering in AMI using individual-level data and small-area estimation methods (Kjærulff et al., 2016). Although many studies have focused on risk factors for CVD, there is a need to study geographical variation in CVD in order to identify new causal factors and thereby limit the geographical inequalities in CVD (Diez Roux, 2009).

Administrative register-based data covering the entire population provide an opportunity to analyze the geographical distribution of AMI without introducing selection bias, e.g. due to voluntary reporting or incomplete coverage of persons with different socio-economic positions. Furthermore, geographical analyses of individual-level data using information about location of residence can be performed using geostatistical methods based on point data. This limits the risk of ecological fallacy due to the modifiable areal unit problem as data are not aggregated in polygons using administrative boundaries (Openshaw and Taylor, 1979).

Geostatistical modeling and spatial analysis are often performed using Bayesian inference with Markov chain Monte Carlo (MCMC) simulations and Gaussian fields (GF). Until recently, analysis of a large number of residential locations was a computational burden when represented as a GF. The Stochastic Partial Differential Equation (SPDE) approach (Lindgren et al., 2011) transforms the continuously indexed GF to a Gaussian Markov random field (GMRF) by triangulation. The GMRF is discretely indexed and this provides a computational advantage compared to the GF as the GMRF is given by a sparse covariance matrix whereas the GF is given by a dense covariance matrix (Lindgren et al., 2011).

In Denmark, healthcare services are tax-financed and free of charge for all citizens. There are approximately 3600 general practitioners (GP) in Denmark. The GPs act as gatekeepers and are the first point of contact in relation to referral to specialists and to in- and out-of-hospital care. The GP plays an important role in primary and secondary prevention of CVD by preventive consultations, prescription of preventive treatments and rehabilitation. A total of 98% of Danes are listed as patient with a GP, the remaining 2% can consult any GP at any time by payment (Andersen et al., 2011; Pedersen et al., 2012). On average, Danes have about 7 GP contacts per year. A total of 15% have no contact to general practice within a year. Each GP was on average responsible for serving 1561 patients in 2008 (Lægeforeningen, 2013).

Studies have indicated inequalities in the geographical distribution of GPs and healthcare clinics (Gravelle & Sutton, 2001; Sanders et al., 2013). To our knowledge, the geographical distribution of GPs in Denmark and its association to CVD health outcomes has not previously been studied. The geographical distribution of GPs is an important issue because the availability of and proximity to GPs are important factors affecting access to primary healthcare. Carr-Hill et al. showed that living in urban areas and relatively near the GP were associated with higher rates of consultation in general practices (Carr-Hill et al., 1996). Studies have identified a number of factors (such as depression, education level, living alone) affecting contact to a GP after an acute disease such as AMI (Nielsen et al., 2015; Ziegelstein et al., 2000).

The aims of this study were to: (1) examine the geographical distribution of a fatal outcome of AMI, and (2) estimate the association between a fatal outcome of AMI and contact to a GP the year before AMI using individual-level addresses and population registers in Denmark.

2. Material and methods

2.1. Register-based data and data linkage

All residents in Denmark (and in the other Nordic countries) have a unique personal identification number given at birth or immigration (Pedersen, 2011). The existence of the unique personal identification number enables individual-level linkage of data from different registers (and other data sources such as surveys) in a reliable manner (Thygesen & Ersbøll, 2014). Individual-level nationwide health-related registers have been established in Denmark providing data such as admission to hospitals (Danish National Patient Register) and cause of death (Danish Register of Causes of Death) (Helweg-Larsen, 2011; Lynge et al., 2011). Location of residence of all Danes (current and historic) is registered and geocoded (Christensen, 2011).

2.2. Study area and population

The study area consisted of Denmark with an area of 43,000 km^2. To evaluate the study objectives the risk of a fatal versus a non-fatal outcome of AMI was compared. Therefore, the study population only included individuals with an AMI (incident or prevalent) in the study period from 1 January, 2006 to 31 December, 2011. This was done as geographical variation in a fatal outcome of AMI in the general population (i.e. including individuals with no AMI) could be seen solely as a consequence of the geographically uneven distribution of AMI. A fatal AMI was defined by the underlying or contributory cause of death in the Danish Register of Causes of Death. A non-fatal AMI was defined by a primary or secondary diagnosis in the Danish National Patient Register. The World Health Organization's International Classification of Diseases, Tenth Revision (ICD-10) was used to identify AMI in both registers (ICD-10 code: I21). Only the first non-fatal AMI was included. An individual could experience first a non-fatal AMI and later a fatal AMI in the study period. The AMI was defined as fatal if a fatal AMI was experienced ≤ 28 days after the first non-fatal AMI (Madsen et al., 2003). If a fatal AMI was experienced >28 days after the first non-fatal AMI, AMI for this individual was defined as non-fatal.

The study population included 69,608 individuals with AMI of whom 17,196 had a fatal outcome of AMI according to the definition described above.

2.3. Characteristics of the study population

Information about address of residential location at date of AMI, date of birth, gender, migration and vital