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Trends and geographical variation of primary hip and knee joint replacement in Germany

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SUMMARY

Objective: Considerable variation in total hip replacement and total knee replacement (THR/TKR) between regions has been described. The aim of this study was to explore geographical variation in THR and TKR in Germany and to analyse potentially explanatory variables.
Method: We used data of Germany's largest statutory health insurer. Between 2005 and 2009 451,108 THR and 335,022 TKR were performed. Age-standardised joint replacement rates were calculated for 16 federal states and 407 counties. We performed cluster (Moran's I) and spatial error regression analyses including regional deprivation, osteoarthritis rate, urbanity and number of orthopaedic specialists as dependent variables on county level.
Results: In 2009 the overall age-standardised and crude rates were 148.9 (95% CI (confidence interval) 147.6–151.1) and 290.2 for THR, and 132.5 (95% CI 131.3–133.6) and 232.7 for TKR. Between counties THR rates differed by factor 2 (106.1–215.8) and showed significant clusters with high utilisation in South and Northwest Germany. TKR rates differed by factor 3.2 (69.1–219.5) and were also high in South Germany whereas almost all areas in East Germany showed low replacement rates. Differences were pronounced when restricting the analysis to cases with an indication of osteoarthritis. All tested predictors could be identified as significant explanatory variables (each $P < 0.001$).
Conclusion: This study proofed considerable and consistent geographic variation of THR and TKR in Germany. Thereby relevant explanatory factors were identified. These results may foster the discussion and future research in health services which should include areas of patients' and doctors' expectation, financial aspects and an outcome-based definition of appropriate supply.

Introduction

Hip osteoarthritis (HOA) and knee osteoarthritis (KOA) are major public health problems associated with considerable loss of health-related quality of life, therapeutic demands, and costs[1]. The prevalence of HOA and KOA varies widely between countries. Sun *et al.* published rates ranging from 0.5% to 36%[2]. Recent population-based studies estimated the prevalence of HOA i.e., KOA with 5.5% i.e., 7.1% for 24–76 year-olds in Norway[3] and 5.0% i.e., 7.6% for 40–75 year-olds in France[4]. For Germany population-based data are scarce[2]. According to an older study on hip X-rays 10% of women and 16% of men over 55 years suffer from HOA[5]. Total hip replacement (THR) and total knee replacement (TKR) became routine therapies in these patients. In Germany 157.719 THR were performed in 2010[6] and 158.100 TKR in 2005.

Both procedures have increased over time[7–9] and vary between countries[10]. Studies reported a high geographical variance of THR and TKR rates also within countries. The US-Dartmouth Atlas Surgery Report 2010 showed THR rates as low as 120 per 100.000 for the states Alexandria and Louisiana and as high as 670 for Boulder and Colorado in Medicare beneficiaries in 2000/2001. Beside Australia[11], geographical variation was also reported for European countries including UK[12] and Finland[13]. No such data have been published for Germany so far. It is assumed also for

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Germany that equity in access to care exists. However, it is important for service planning to analyse and provide data on the actual situation. Joint replacements as common elective procedures should be a good candidate to study inequity.

We aimed to analyse THR and TKR rates for Germany, based on a nationwide large sample of members of the major statutory health insurance company. Geographical analyses were performed on a large (federal states) and small (counties) scale in order to elucidate indications of inequality of healthcare. In addition we analysed potentially relevant explanatory variables.

Methods

Data source

These analyses are based on data of in-patients, who are members of the largest of about 150 statutory health insurer in Germany (Allgemeine Ortskrankenkasse (AOK) = local health insurance fund). Roughly 24 million people are insured under the regional AOKs – close to one-third of the German population. The AOK is a nationwide insurer and members will be treated in all licensed hospitals. Data of the period 2005–2009 were provided by the research institute of this insurance company (WIdO). Only cases with primary THR or TKR, defined by operation and procedure code (OPS) codes (see Appendix), were considered.

Statistical analyses

- Trend analyses

  For trend analyses we summarized the crude number of procedures per year including multiple counts in case one patient received e.g., two THR in 1 year. Differences between the last and first observation period were expressed in percent change and Chi-square tests were used to test for significant difference between these observations.
- Crude rates

  We calculated crude rates by using the number of affected patients as nominator. This implies that one patient is counted only once per period even if the patient had e.g., two THR in 1 year. The denominator consisted of all members of the insurance company either nationwide or in the corresponding geographic unit in case of geographical analyses. The denominator population is given by year and together with the proportion of males in Table A1 of the appendix.
- Standardised rates

  For the geographical analyses we calculated age-standardised rates of THR/TKR per 100.000 insured. We used the European age standard from 1966 in 10-years-groups. Thereby we assured comparability of the rates within our study and with international publications. Since the age standard is on average much younger than the population we investigated, crude and standardised rates differed.
- Stratification by diagnosis

  In order to separate cases who were operated primarily for a traumatic reason from those who got an elective procedure mainly due to osteoarthritis we built two diagnostic groups, trauma and osteoarthritis, based on the main International Statistical Classification of Diseases and Related Health Problems (ICD) diagnostic codes and performed stratified analyses for both groups. The used specific codes for both groups are given in Table A3 in the appendix. Not all cases could be assigned to one of these groups.
- Geographical analyses

  We calculated age-standardised rates for two geographical units, the 16 federal states including the Cities of Berlin, Hamburg, and Bremen and 412 counties (as effective on January 01 2011), based on the patients' place of residence. For sample size reasons the analyses for counties are based on the aggregated data of 2005–2009, whereas the results for federal states are based on the most recent data of 2009. Five counties with less than 25 observed cases or a population under risk below 125 insurants were excluded. The boundaries of the counties changed over the observation period but the mapping of cases and population was carried out in retrospect in a consistent pattern. The population (insured people) varied between counties (mean 306,827, median 234,139, min. 38,288, max. 3,972,833 over the time period 2005–2009).

  Patients and population under risk (insured people) were assigned to a geographical unit by the five-digit postal code. The geographic maps were provided by the Federal Agency for Cartography and Geodesy in Frankfurt/Main, Germany. The postal codes of 52,381 (3.6% of the gross sample) datasets could not be assigned to a county and were excluded together with the corresponding denominator population. The postal codes of 3,493 (0.2% of the gross sample) datasets could not be assigned to a federal state. In this case the seat of the insurance company, which is represented in all federal states, was taken as location reference. A total of 2,558 cases had to be excluded because of missing data on the place of residence. Furthermore there were missing data for the second half of the year 2009 for the City of Bremen. Therefore the city was censored in the analyses by federal states.

  All maps in the publication were made with ArcMap10, esri.
- Spatial autocorrelation

  To test whether there is a spatial autocorrelation in the data we used Moran's I[14] a common measure which can vary between −1 (perfect dispersion), 0 (random spatial pattern) and +1 (perfect correlation). A positive spatial autocorrelation means that areas with similar values tend to be closer – counties with high age-standardized THR/TKR rates tend to be adjacent to other counties with high rates and *vice versa*. Adjacency is assumed when two counties have a common point of boundary (queen's criteria).
- Cluster analysis

  As a continuation of the spatial autocorrelation analysis we carried out a (Local Indicators of Spatial association (LISA)) analysis[15]. It is a kind of a local Moran's I and can be interpreted as a cluster test similar to the G_i statistic of Gettis and Ord[16]. LISA identified areas with clusters of counties in the map which high–high or low–low values (positive spatial autocorrelation). In the map areas were displayed in dark red if adjacent counties had statistical significant high rates of age-standardised THR/TKR rates, in dark blue if they had significant low rates, and in grey if results were not significant. In rare cases there was a negative spatial autocorrelation – a county with low rates in adjacent to counties with high rates or *vice versa* (displayed light blue/red). Such cases were seen as outliers.
- Regression models

  As an ecological approach we fitted a regression model with the German counties as units of analysis. Outcome variable were the age-standardized THR and TKR rates (with indication osteoarthritis) measured at the county level. Predictors (measured at the county level, too) were the regional deprivation, the number of orthopaedic specialists, the age-standardised rate of KOA or HOA, and a variable of urbanity. Regional deprivation was measured using the German Index of Multiple Deprivation (GIMD) provided by W. Maier[17]. This index comprises seven deprivation domains (income, employment, education, district revenue social capital, environment, security). Each domain contains one or more