# Epidemiology and Variability of Orthopaedic Procedures Worldwide

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## Introduction

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) have been proven as efficacious and cost-effective interventions in the treatment of osteoarthritis [1, 2]. Osteoarthritis remains as the main indication for those procedures [3–5], despite few Asian studies regarding THA reported otherwise [6, 7]. Also, THA and TKA are becoming safer, as mortality and complications rates, and length of stay in hospital decrease, despite the increase in comorbidities in patients selected for those procedures [8, 9].

The number of THA and TKA has been increasing [4, 5, 8–16], but TKA rates have been increasing at a higher rate than THA. As osteoarthritis affects more of the elderly, part of this increase may be explained by population ageing. There is a strong association between high body mass index (BMI) and knee osteoarthritis [17]. As obesity becomes more prevalent, osteoarthritis rises and THA and TKA rates rise concomitantly. Moreover, association between high body mass index and hip and knee arthroplasties has been described [18]. Increase in THA and TKA can also be attributed to changes in criteria for selecting the patients for surgery. Better devices and better materials allow TKA to be increasingly performed in younger people [5, 9, 11], and account for the broadening of criteria and TKA rates increase. Not only criteria are broadening but also inter-hospital variability in clinical criteria have been reported in Spain [19], despite another study from a hospital in Iowa which did not find such variability between surgeons [20]. Further increase in THA and TKA is predicted, making the projected increase more accentuated in TKA [21].

Studies regarding THA revision and TKA revision trends have shown inconsistent results. Many studies reported that revision rates have been increasing [10, 13, 15, 22], even though some of them are not statistically significant and projections point that the revision burden is expected not to increase [21]. On the other hand, Scandinavian studies reported a decreasing in THA revision risk, mainly due to a decrease in aseptic loosening of both components [23]. The most common indications for THA revision are instability and/or dislocation, implant loosening and infection [23, 24], and for TKA are infection and implant loosening [25].

There are disparities in rates of THA and TKA between poorer and wealthier, with the wealthier populations showing higher rates [10]. A study, including nine European Union members, showed that the mean cost of primary THA was 5,043 € in 2008, the type of implant and the ward cost being the most important cost-drivers. This study also showed that almost 80% of the explainable price variation between countries is explained by purchasing-power priorities [26].

Arthroplasty register data can provide a crucial contribution for development of arthroplasties and quality control, allowing assessment of the number and epidemiology of procedures, rates of revision and corresponding causes of failure [27, 28]. The first arthroplasty register was created in Sweden in 1975. Since then, several national orthopedic societies have created their own arthroplasty registers and nowadays Sweden, Finland, Norway, Denmark, New Zealand, Hungary, Australia, Canada, Czech Republic, Romania, Slovakia, Slovenia, Portugal, Moldavia, Austria, England and Wales have active arthroplasty registers.

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Several other countries have projected, or have already established a pilot phase of arthroplasty registers [29].

Minimal datasets have been established by the European Federation of National Associations of Orthopaedics and Traumatology (EFORT). The European Arthroplasty Register (EAR) is an EFORT project, created to co-ordinate the co-operation between the several Arthroplasty Registers in Europe. As far as we know there are no studies of geographical patterns of arthroplasty incidence rates between countries.

Our goals are to analyze the worldwide geographic distribution of incidence rates of THA and TKA and to identify socio-economic and health determinants for such incidences.

## Materials and Methods

### Data

Procedures coded by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD9-CM) for THA and for TKR, comprising both primary and revision procedures, were selected: codes 81.51 and 81.54 for THA and codes 81.53 and 81.55 for TKA. It was not possible to have disaggregated data for all the countries and therefore primary and revision procedures were analyzed together. Regarding THA, data from 31 countries were used while for TKA data from 28 countries were used.

Data on knee arthroplasty procedures (number of inpatient cases in 2007, unless a different year is mentioned) for 23 countries – Australia (2006), Austria (2005), Belgium (2006), Canada, Denmark (2005), Finland, France, Germany, Hungary, Iceland, Ireland, Italy (2006), South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States (2006) – and also for the 1990–2007 time interval, were obtained from the Organization of Economic-Cooperation and Development (OECD). For Romania [30], Czech Republic [31], Slovakia [32] and Norway [33], data about the number of knee arthroplasties came from National Annual Reports of the operating arthroplasty registers. Data from Slovenia was estimated based on the Valdoltra Hospital arthroplasties register, which accounts for 50% of all procedures in Slovenia. The database of the Hospital Admissions Authorization (Autorização de Internação Hospitalar – AIH), from the Health System of Brazil was used to identify primary and revision knee arthroplasty operations. The AIH is used nationwide in all public hospitals as well as in private hospitals that provide services to the national health system. In Brazil, the national system of health is universal and free for all the population, although, about 25% of the population above 40-years old has a private health insurance and goes to private hospitals. Hospital admissions, from private health insurances were not available to use in this study.

Most data on hip arthroplasty procedures (number of inpatient cases in 2007, unless stated) also came from the OECD health data and was available for 26 countries – Australia (2006), Austria (2005), Belgium (2006), Canada (2006), Denmark, Finland, France, Germany, Greece (1999), Hungary, Iceland, Ireland, Italy, South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States (2006). As mentioned above, for Romania, Czech Republic, Slovenia, Slovakia and Norway, data were retrieved from the Annual Reports of the national arthroplasty registers. From Brazil data refers to hospital admissions to public hospitals and from Slovenia data was estimated from the Valdoltra register of arthroplasties.

Population data (denominator) was obtained from the European Commission Eurostat, U.S. Census Bureau, Statistics Canada, Statistics Mexico, Statistics of New Zealand and the UK Office for National Statistics. Socioeconomic data came from several sources: GINI coefficient, which measures the degree of inequality in the distribution of family income in a country, was obtained from CIA World Factbook [34]. Human Development Index (HDI) is a composite index that measures average achievement in three basic dimensions of human development – a long and healthy life, knowledge and a decent standard of living. It is produced annually by United Nations Development Programme (UNDP) and data used in the present work came from Human Development UNDP Statistics [35].

The following variables for OECD countries were selected: number of coxarthrosis and gonarthrosis hospital discharges; number of THA and TKA procedures; number of medical Doctors per 100,000 inhabitants; Number of medical consultations per capita; Number of hospital beds per 1,000 inhabitants; Perception of health system as good or very good by the population(%); Public Current Expenditure on Health per capita (US$); % of Public Expenditure on Health compared to the Total Expenditure on Health; Investment on Medical Facilities (% of the total current expenditure on health); Total Expenditure on Health, % of Gross Domestic Product; Total Expenditure on Health per capita (US$); Percentage of overweight and obesity and Age-Standardized Prevalence of diabetes (%). From the EuroStat. and other official statistic sources the percentage of population over 65 years and the percentage of women among the population over 65 years were calculated.

### Statistical Analysis

In order to allow the comparison between countries, the Age-Standardized Incidence Rates (ASIR) for THA and TKA were computed using the indirect method and England and Wales (2009) as the reference population. This method comprises the calculating of the ratio between the observed cases and the expected cases, if the population of study had the same cases distribution of the reference population. This ratio is known has Standard Morbidity (or Mortality) Ratio – SMR and values above 100% indicate an excess of risk, while values under 100% indicate a lower risk than the reference population. The indirect method has the disadvantage of not being appropriate to compare between areas: rather, the comparison has to be done by pairs, each area being compared with the reference population. That's the reason for being called the "indirect" method. Although less usual than the direct standardization, the indirect method is the alternative to be used when the number of cases for each age-group in the study areas is not available. In the present study, 2009 data from National Joint Registry (NJR) of England and Wales was chosen as standard population because it provides data with good quality from both National Health Service and private health-care sector. Furthermore, the National Joint Registry (NJR) of England and Wales allows extraction data by 10-year age-groups (<45; 45–54; 55–64; 65–74; 75–84; >85) in order to calculate the indirect standardization. Additionally, England and Wales have a quite numerous population, comprising 89% of all UK inhabitants in 2009. Data were selected from the 7th Annual Report of the NJR [36].

The ASIR of THA and TKA were calculated for the most recent available data. The annual percentage change in the number of arthroplasty procedures between 2000 and 2007 were estimated by linear regression.

Multiple regression analysis was used to determine which variables were related to the ASIR of THA and TKA (the dependent variables). Sample size in each variable analysis varied due to missing data. A *p-value* $<0.05$ was considered statistically significant.

Geographical Information Systems (GIS) and Spatial Statistical techniques were used to analyse the data and map the results. The Moran Index (I) was computed in order to measure the spatial autocorrelation, that is, the correlation between incidence rates in different countries [37]. First-order neighbourhood relation was defined by the sharing of common boundaries between countries. Moran's I is a global indicator of auto-correlation and provides a single value for all the set of data. The interpretation of such an index is similar to the interpretation of the $r$ in a linear correlation. If it is close to zero, it means that there is no auto-correlation, and the events occur randomly in space, otherwise, if it's close to 1 or −1 it means there is a strong (positive or negative) auto-correlation and indicates that there is a spatial dependency in the occurrence of the events, meaning that what happens in one country is correlated with what happens in the surrounding countries and the events do not occur randomly. However, when dealing with large areas, it is possible that different spatial associations occur; therefore, one single value would not represent the underlying patterns. To deal with these different spatial associations the local Moran Index, known as Local Index of Spatial Auto-correlation – LISA was calculated [38]. The LISA indicates the presence of spatial dependence in some areas, that is, areas where the incidence rates are significantly correlated with the incidence rates of their neighbours.

Statistical analysis was completed using the SPSS v17.0 for multiple regression analysis and GeoDa 0.9.5-i for spatial statistical analysis. ArcMap v9.3 was used to map the results.

## Results

The study included 31 countries with a total population of 1,197,214,619 persons and 1,422,046 THA, corresponding to a crude incidence rate in 2007 of 118.8 (118.4–119.2) per 100,000 persons-year. Regarding the TKA, the 28 countries included in the study had 1,198,148 TKA, corresponding to a crude rate of 104.3 (103.9–104.7) per 100,000 persons-year.

Age-Standardized Incidence Rates (ASIR) and Standard Morbidity Ratios (SMR) for THA and TKA are presented in Table 1. Strong geographic disparities were observed. In Europe, the ratio between the highest and lowest ASIR (95% CI), per 100,000 inhabitants, was H:L = 7.5, with Austria [266.2 (269.7–273.3)] having the highest and Romania [35.4 (36.3–37.1)] the lowest ASIR. For TKA the extremes were again between Austria [183.6 (186.5–189.5)] and Romania [5.3 (5.6–5.9)] but disparities were

**Table 1** Age-standardized incidence rates (ASIR) for total hip and knee arthroplasties

| Country | Total hip arthroplasties – THA/100,000 persons-year | | Total knee arthroplasties – TKA/100,000 persons-year | |
|---|---|---|---|---|
| | SMR (95% CI) | ASIR (95% CI) | SMR_TKA | ASIR (95% CI) |
| Australia[a] | 154.8 (156.5–158.3) | 172.9 (174.8–176.8) | 136.3 (137.9–139.4) | 171.3 (173.2–175.2) |
| Austria[b] | 238.3 (241.5–244.7) | 266.2 (269.7–273.3) | 146.1 (148.5–150.8) | 183.6 (186.5–189.5) |
| Belgium[a] | 199.2 (201.7–204.2) | 222.5 (225.3–228.1) | 118.8 (120.6–122.4) | 149.2 (151.5–153.8) |
| Canada[c] | 113.3 (114.4–115.5) | 126.5 (127.8–129.0) | 114.8 (115.9–116.9) | 144.3 (145.6–146.9) |
| Czech Republic[a,d] | 81.9 (83.6–85.3) | 91.5 (93.3–95.3) | – | – |
| Denmark[e] | 175.5 (178.8–182.2) | 196.0 (199.7–203.5) | 83.4 (85.6–87.9) | 104.8 (107.6–110.4) |
| Finland | 149.4 (152.4–155.5) | 166.9 (170.2–173.7) | 125.0 (127.6–130.2) | 157.0 (160.3–163.7) |
| France | 192.3 (193.3–194.3) | 214.8 (215.9–217.1) | 85.9 (86.6–87.2) | 108.0 (108.8–109.6) |
| Germany | 215.7 (216.6–217.5) | 240.9 (241.9–242.9) | 131.7 (132.4–133.0) | 165.5 (166.3–167.1) |
| Greece[f] | 53.5 (54.8–56.2) | 59.8 (61.3–62.7) | – | – |
| Hungary | 77.0 (78.6–80.2) | 86.0 (87.8–89.6) | 31.3 (32.3–33.3) | 39.4 (40.6–41.9) |
| Iceland | 160.4 (175.8–192.3) | 179.1 (196.3–214.7) | 99.1 (110.6–123.2) | 124.5 (139.0–154.8) |
| Ireland | 152.3 (156.3–160.4) | 170.1 (174.6–179.2) | 45.8 (48.0–50.2) | 57.6 (60.3–63.0) |
| Italy[g] | 116.4 (117.2–117.9) | 130.0 (130.9–131.7) | 60.3 (60.8–61.3) | 75.8 (76.4–77.1) |
| South Korea | 16.7 (17.1–17.5) | 18.7 (19.1–19.5) | 78.2 (79.0–79.8) | 98.3 (99.3–100.3) |
| Luxembourg | 202.3 (215.2–228.7) | 226.0 (240.3–255.4) | 127.8 (137.5–147.7) | 160.6 (172.8–185.6) |
| Mexico | 14.2 (14.6–14.9) | 15.9 (16.3–16.6) | 6.2 (6.4–6.6) | 7.8 (8.0–8.3) |
| Netherlands | 188.9 (191.0–193.0) | 211.0 (213.3–215.6) | 98.0 (99.4–100.8) | 123.1 (124.8–126.6) |
| New Zealand | 149.9 (153.8–157.7) | 167.4 (171.7–176.1) | 90.5 (93.4–96.3) | 113.7 (117.3–121.0) |
| Norway[d] | 182.7 (186.5–190.4) | 204.1 (208.3–212.6) | 68.6 (70.8–73.0) | 86.2 (88.9–91.8) |
| Poland | 32.6 (33.2–33.8) | 36.4 (37.1–37.7) | – | – |
| Portugal | 67.4 (68.9–70.4) | 75.3 (76.9–78.6) | 34.0 (34.9–35.9) | 42.7 (43.9–45.2) |
| Slovenia[h] | 80.5 (76.8–84.2) | 89.9 (85.8–94.1) | 44.8 (42.3–47.5) | 56.3 (53.1–59.7) |
| Slovak Republic | 88.6 (91.2–93.9) | 99.0 (101.9–104.9) | 22.7 (23.9–25.2) | 28.5 (30.1–31.7) |
| Spain | 86.0 (86.9–87.7) | 96.1 (97.0–97.9) | 80.6 (81.3–82.1) | 101.3 (102.2–103.1) |
| Sweden | 171.1 (173.6–176.1) | 191.1 (193.9–196.7) | 80.5 (82.1–83.7) | 101.1 (103.1–105.2) |
| Switzerland | 202.2 (205.2–208.3) | 225.8 (229.2–232.6) | 138.1 (140.5–142.9) | 173.6 (176.5–179.5) |
| United Kingdom | 165.5 (166.5–167.4) | 184.8 (185.9–187.0) | 109.1 (109.9–110.6) | 137.1 (138.0–139.0) |
| United States[a] | 171.9 (172.4–172.9) | 192.0 (192.5–193.1) | 176.3 (176.7–177.2) | 221.5 (222.0–222.6) |
| Brazil[d] | 10.1 (10.3–10.5) | 11.3 (11.5–11.7) | 3.4 (3.5–3.6) | 4.3 (4.4–4.5) |
| Romania[d] | 31.7 (32.5–33.2) | 35.4 (36.3–37.1) | 4.2 (4.5–4.7) | 5.3 (5.6–5.9) |

[a]Last available year 2006
[b]Last available year 2005
[c]Last available year for THA 2006
[d]Other sources (not OECD data)
[e]Last available year for TKA 2005
[f]Last available year 1999
[g]Last available year for TKA 2006
[h]Estimated from Valdoltra Arthroplasties Register. Doesn't include revisions

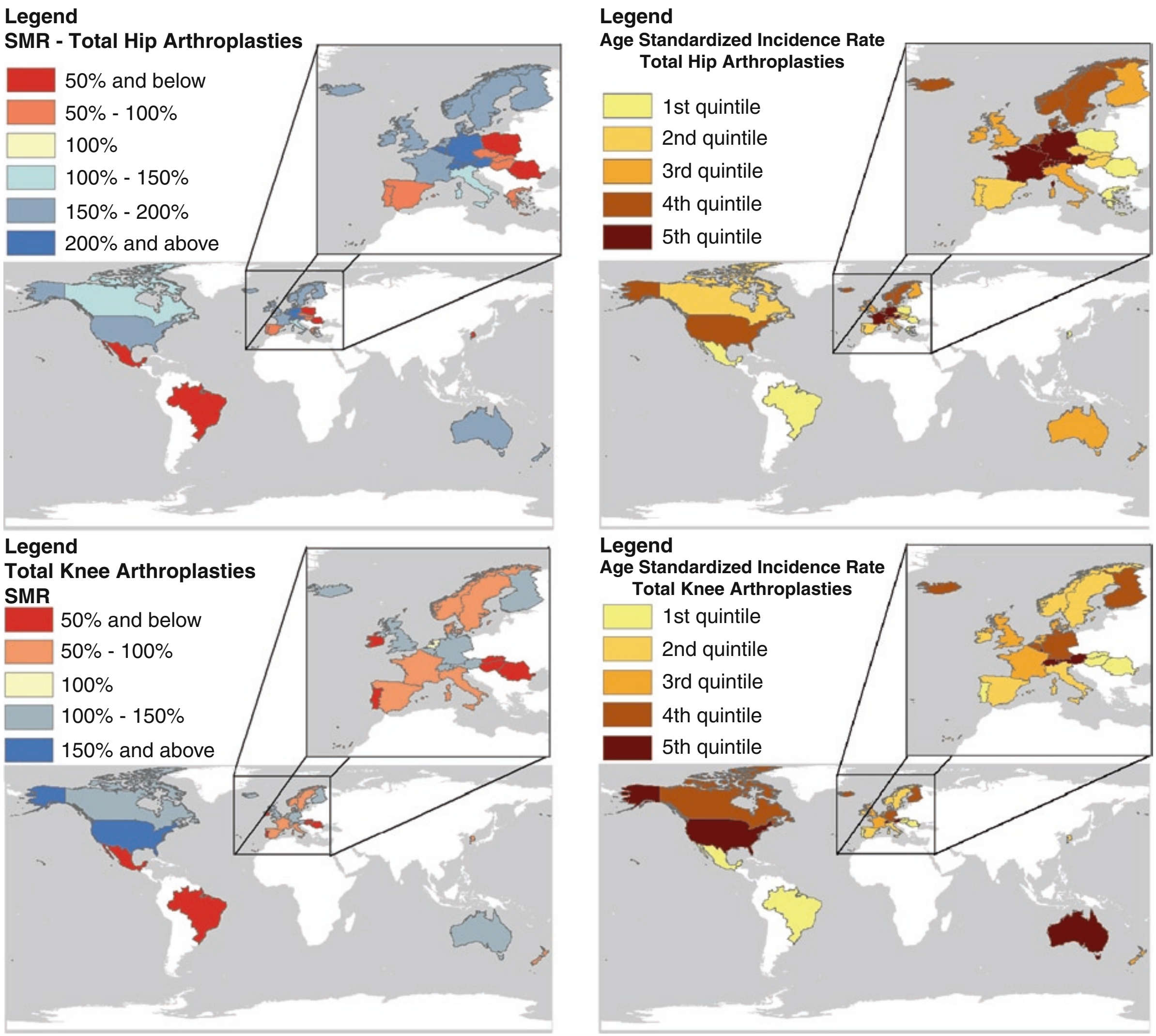


**Fig. 1** Standard morbidity rate (*SMR*) and age-standardized incidence rates (*ASIR*), of total hip and knee arthroplasties worldwide in 2007

much more accentuated, being the ratio H:L = 34.6. Figure 1 presents the geographical distribution of ASIR and SMR of THA and TKA, worldwide in 2007. A closer look at age-standardized incidence rates in Europe is showed in Figs. 2 and 3, respectively for THA and TKA where a cluster of countries with high ASIR seems to emerge. The significance of such spatial clusters were tested with the Local Index of Spatial Autocorrelation – LISA, and confirmed only for THA (Fig. 4), with six countries of central-north Europe aggregating with higher ASIR of THA. For ASIR of TKA there were no significant spatial clusters. The global index of spatial autocorrelation, Moran Index (I) was moderate for THA (0.26) and null for TKA (0.0043).

To develop the regression analysis, a correlation matrix (Table 2) was prepared, regarding the ASIR of THA and TKA, and the selected variables. Statistically significant correlations were observed mainly with economic and macro-economic variables.

Using the enter method, significant models emerged for THA ($F_{7.42} = 11.737$ $p < 0.0005$, adjusted $R^2 = 0.782$) and for TKA ($F_{5.16} = 8.702$ $p < 0.0005$, adjusted $R^2 = 0.647$).

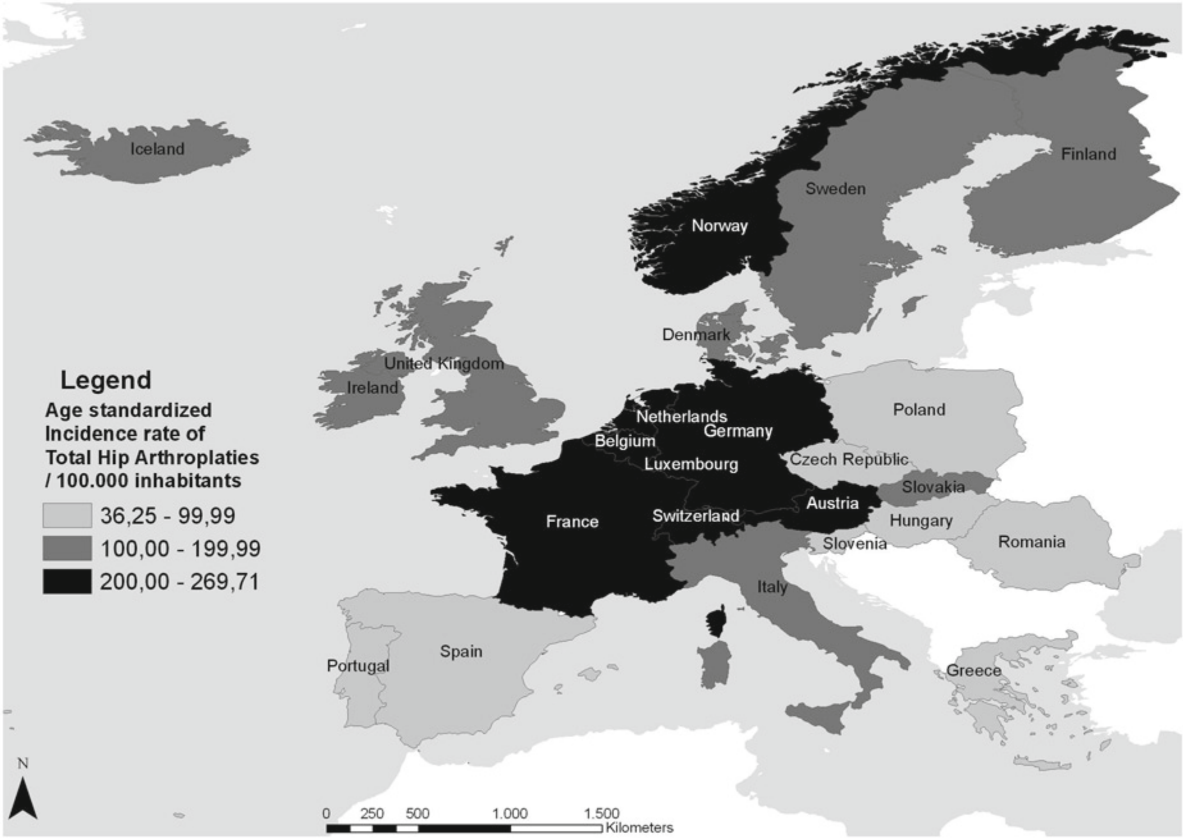


**Fig. 2** Age-standardized incidence rates of total hip arthroplasties (*THA*) in Europe (2007)

After removing independent variables that were highly correlated among them, the determinant variables for ASIR of THA were: Growing of the number of THA between 2000 and 2007; number of medical consultations per capita; % of population recognizing the health system as good or very good ($p<0.05$); Total Expenditure on Health, related to % of Gross Domestic Product; % of people with 65 and more years old ($p<0.05$); Human Development Index; and Gross Domestic Product of 2007 ($p<0.05$). The coefficients of the model are presented in Table 3.

Regarding the ASIR of TKA, the determinant variables were: % of population perceiving the health system as good or very good; Human Development Index 2007; Gross Domestic Product of 2007; % of people with 65 and more years old; and Total Expenditure on Health , per capita (US$). The coefficients of this model are presented in Table 4.

## Discussion

In this study we aimed to look for determinants of the incidence of hip and knee arthroplasties worldwide, that could explain the strong geographic inequalities. We wish to understand if the inequalities were related to differences in health risks among countries, for instance, differences in the percentage of elderly people, overweight and obesity, incidence of osteoarthrosis or other health-related variables. A set of several variables covering health, demographic, economic and social aspects were selected to define the model that better explains the variability of arthroplasty procedures worldwide.

Contrary to that described in other studies, obesity and incidence of osteoarthritis (measured as number of hospital discharges of patients with coxarthrosis and gonarthrosis) were not determinants of the incidence of THA and TKA.

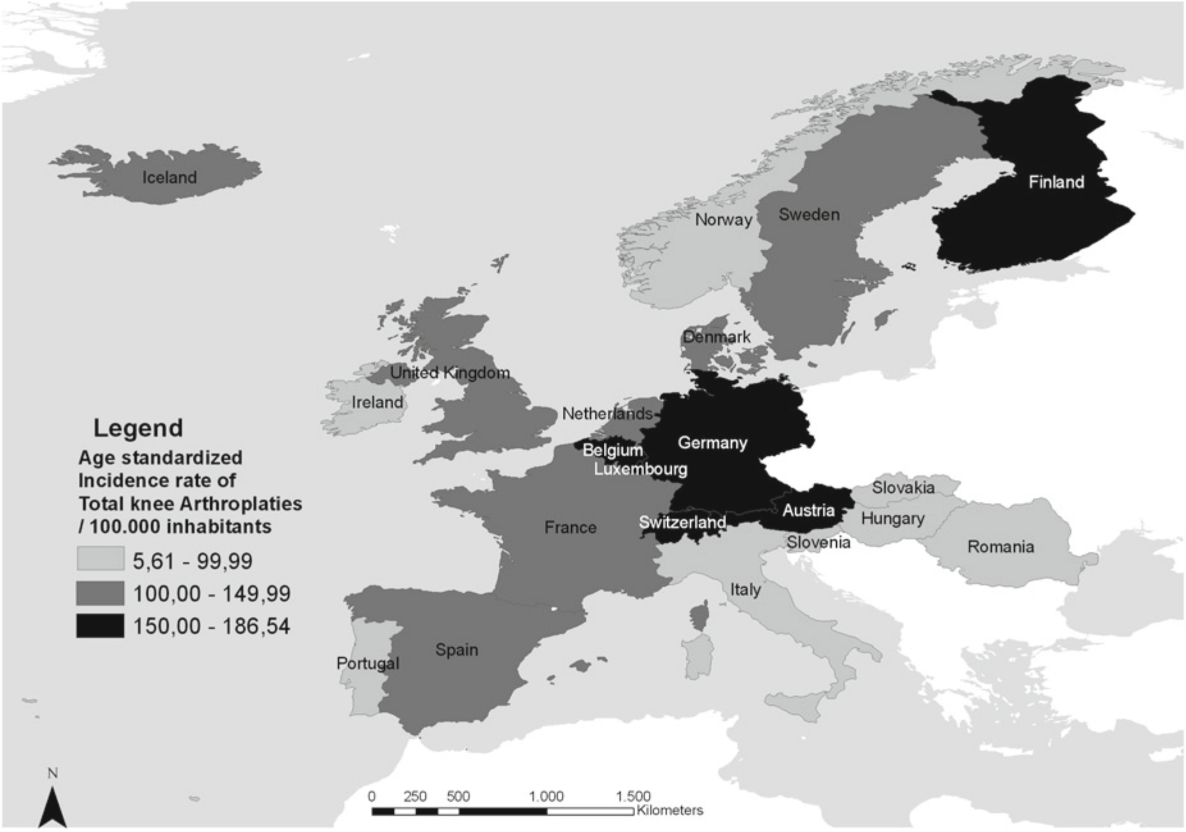


**Fig. 3** Age-standardized incidence rates of total knee arthroplasties (*TKA*) in Europe (2007)

The disparities between poorer and wealthier, [10] seem to be the better explanation for the high variability among ASIR between countries, being the economic variables those who presented the highest Pearson's correlation coefficients (Table 2). Quality of health systems measured as the proportion of the population who declared it to be good or very good, as well as the public investments in health systems, were determinants of the incidence of arthroplasties, both for the THA and TKA. However, variables such as Investment on Medical Facilities, number of medical doctors per hundred thousand inhabitants, number of medical consultations per capita and number of hospital beds per thousand inhabitants are not associated with the incidence of arthroplasties.

The Moran's I coefficients for spatial auto-correlation presented moderate values for ASIR of THA, showing a positive spatial auto-correlation, meaning that in nearby countries the incidence of THA tends to have similar values. However, for the incidence of TKA no spatial auto-correlation was found. The statistically significant local spatial auto-correlation (Fig. 4) showed that one cluster of six countries with higher incidence rates of THA is occurring in central Europe. The highest incidence of such arthroplasties is related to higher Gross Domestic Product and Human Development Index. We believe that the disparities encountered in the geographical distribution of age-standardized incidence rates of THA and TKA are not related to differences in risk, rather reflects differences in health priorities. Arthroplasties help to reduce pain and improve the quality of life of patients. They are not surgeries to "save lifes" and health systems in less rich countries may have other priorities. Nevertheless, future studies need to be done to test this hypothesis.

This study has some limitations, mainly related to the availability of data. For countries which are non-members of the OECD, the variety of social, economic and health

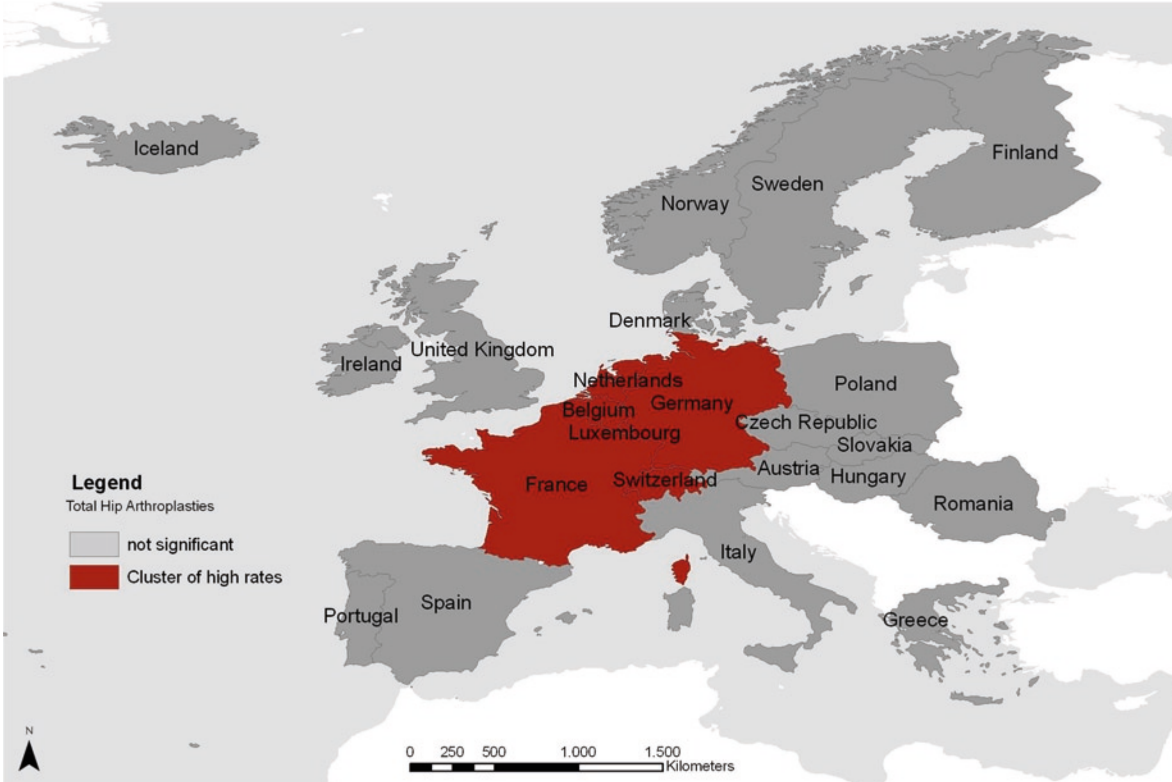


**Fig. 4** Spatial clusters of age-standardized incidence rates for total hip arthroplasties

variables was much more limited than for the OECD countries. The last available data was not the same for all the variables, and when 2007 data were not available, we used data from 2006 or 2005. If data were from previous years we considered that were not available, except in what respects to number of arthroplasties in Greece (last available data was from 1999).

Our study brings a new contribution to the knowledge of the incidence of arthroplasties worldwide. The determinants for such procedures seemed to be oriented by economic aspects, rather than health needs, with wealthier countries having a better performance. It would be interesting to evaluate the medical protocols for indications for an arthroplasty in the different countries.

**Table 2** Correlation matrix between analysed variables, THA and TKA

| | | Age standardized incidence rate of THA | Age-standardized incidence rate of TKA |
|---|---|---|---|
| Number of coxarthrosis hospital discharges | Pearson correlation | 0.292 | 0.420 |
| | Sig. (2-tailed) | 0.148 | **0.041** |
| Number of gonarthrosis hospital discharges | Pearson correlation | 0.208 | 0.476 |
| | Sig. (2-tailed) | 0.307 | **0.019** |
| Number of THA procedures | Pearson correlation | 0.276 | 0.459 |
| | Sig. (2-tailed) | 0.133 | **0.014** |
| Number of TKA procedures | Pearson correlation | 0.177 | 0.463 |
| | Sig. (2-tailed) | 0.369 | **0.013** |

**Table 2** (continued)

| | | Age standardized incidence rate of THA | Age-standardized incidence rate of TKA |
|---|---|---|---|
| Growing in the number of THA between 2000 and 2007 | Pearson correlation | −0.447 | 0.144 |
| | Sig. (2-tailed) | **0.025** | 0.502 |
| Growing in the number of TKA between 2000 and 2007 | Pearson correlation | −0.365 | 0.009 |
| | Sig. (2-tailed) | **0.087** | 0.968 |
| Medical doctors per 100,000 inhabitants | Pearson correlation | 0.284 | −0.087 |
| | Sig. (2-tailed) | 0.159 | 0.694 |
| Number of medical consultations per capita | Pearson correlation | −0.315 | −0.240 |
| | Sig. (2-tailed) | 0.133 | 0.282 |
| Number of hospital beds per 1,000 inhabitants | Pearson correlation | 0.043 | 0.102 |
| | Sig. (2-tailed) | 0.840 | 0.651 |
| Perception of health system as good or very good (%) | Pearson correlation | **0.663** | **0.515** |
| | Sig. (2-tailed) | **0.000** | **0.014** |
| Public Current Expenditure on Health per capita (US$) | Pearson correlation | **0.841** | **0.524** |
| | Sig. (2-tailed) | **0.000** | **0.009** |
| % of Public Expenditure on Health compared to Total Expenditure on Health | Pearson correlation | 0.495 | 0.055 |
| | Sig. (2-tailed) | **0.010** | 0.804 |
| Investment on Medical Facilities (% of the total current expenditure on health) | Pearson correlation | 0.029 | 0.170 |
| | Sig. (2-tailed) | 0.889 | 0.448 |
| Total Expenditure on Health, % of Gross Domestic Product | Pearson correlation | **0.535** | **0.616** |
| | Sig. (2-tailed) | **0.003** | **0.001** |
| Total Expenditure on Health per capita (US$) | Pearson correlation | **0.746** | **0.783** |
| | Sig. (2-tailed) | **0.000** | **0.000** |
| Percentage of overweight and obesity | Pearson correlation | −0.098 | 0.021 |
| | Sig. (2-tailed) | 0.634 | 0.926 |
| Age-Standardized Prevalence of diabetes (%) | Pearson correlation | −0.265 | 0.063 |
| | Sig. (2-tailed) | 0.173 | 0.767 |
| % of population with 65 and above years | Pearson correlation | 0.434 | 0.344 |
| | Sig. (2-tailed) | **0.015** | 0.073 |
| % of women, among population with 65 and more years | Pearson correlation | −0.177 | −0.133 |
| | Sig. (2-tailed) | 0.340 | 0.500 |
| Life expectancy | Pearson correlation | **0.654** | **0.681** |
| | Sig. (2-tailed) | **0.000** | **0.000** |
| GINI Index | Pearson correlation | −0.477 | − 0.289 |
| | Sig. (2-tailed) | **0.007** | 0.136 |
| Human Development Index | Pearson correlation | **0.711** | **0.716** |
| | Sig. (2-tailed) | **0.000** | **0.000** |
| Gross Domestic Product | Pearson correlation | **0.777** | **0.521** |
| | Sig. (2-tailed) | **0.000** | **0.008** |

**Table 3** Coefficients from the regression analysis of THA ($R^2=0.782$)

| Variables | Standardized beta | *t* | *p-value* |
|---|---|---|---|
| (Constant) | | −1.183 | 0.256 |
| Growing of the number of THA between 2000 and 2007 | −.074 | −.518 | .613 |
| Number of medical consultations per capita | .240 | 1.376 | .191 |
| % of population perceiving the health system as good or very good | .556 | 2.808 | .014 |
| Total Expenditure on Health, related to % of Gross Domestic Product | .107 | .765 | .457 |
| % of people with 65 and more years old | .397 | 2.602 | .021 |
| Human Development Index 2007 | −.172 | −.689 | .502 |
| Gross Domestic Product of 2007 | .542 | 2.816 | .014 |

**Table 4** Coefficients from the regression analysis of TKA ($R^2=0.647$)

| Variables | Standardized beta | *t* | *p-value* |
|---|---|---|---|
| (Constant) | | −2.209 | 0.042 |
| % of population perceiving the health system as good or very good | .098 | .549 | .590 |
| Human Development Index 2007 | .379 | 1.765 | .097 |
| Gross Domestic Product of 2007 | −.363 | −1.653 | .118 |
| % of people with 65 and more years old | .136 | .916 | .373 |
| Total Expenditure on Health, per capita (US$) | .704 | 3.104 | .007 |

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