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An ecological study of publicly funded elective hip arthroplasties in Brazil and Scotland: do access inequalities reinforce the inverse care law?

Jonathan Filippon[1], Stephen Bremner[2], Ligia Giovanella[3] and Allyson Pollock[4]

[1]Institute of Population Health Sciences, Queen Mary University of London, London E1 2AB, UK
[2]Brighton and Sussex Medical School, Brighton BN1 9PX, UK
[3]National School of Public Health, Oswaldo Cruz Foundation, Rio de Janeiro 21031-210, Brazil
[4]Institute of Population Health Sciences, Centre for Regulatory Sciences, Newcastle University, Newcastle NE1 7RU, UK
Corresponding author: Jonathan Filippon. Email: j.filippon@qmul.ac.uk

Summary

Objectives: To compare elective hip arthroplasty rates funded by the public sector in Brazil and Scotland.
Design: Ecological study, 2009–13, of crude and directly standardised rates of elective primary hip arthroplasty rates (per 100,000) funded by the public sector at national and regional level for age (30 + years) and gender in Brazil and Scotland.
Setting: National Health Service Scotland and Unified Health System in Brazil.
Participants: Over 30 s who had undergone an elective hip arthroplasty funded by the public sector.
Main outcome measures: Publicly funded standardised elective hip arthroplasty rates in Brazil and Scotland.
Results: Between 2009 and 2013, there was a seven-fold difference in treatment rates between Brazil and Scotland, and an eight-fold regional difference in Brazil; Brazil (7.8–8.3/100,000, increase of 0.5 per 100,000, 95% confidence interval (CI) (0.3, 0.7) from 2009/10 to 2012/13) and Scotland (from 61.1 to 57.7/100,000, decrease of 3.4 per 100,000, 95% confidence interval (1.4, 5.8) per 100,000); a two-fold difference in number of public beds per head of population (Brazil 158.3/100,000 vs. Scotland 305.1/100,000) and general medical workforce (Brazil 198.8/100,000 vs. Scotland 327.4/100,000); numbers of orthopaedic surgeons per head of population in the two countries were similar in 2013 (Brazil 5.2/100,000 vs. Scotland 4.3/100,000).
Conclusion: Although the 'inverse care law' is seen in both countries, access to publicly funded hip arthroplasties in Brazil is worse than in Scotland; the distribution of specialists and higher treatment rates in Brazil is highly skewed towards wealthier areas, perpetuating historical regional inequalities.

Keywords

Access to healthcare, health inequalities, international health, public health

Introduction

Hip arthroplasty, commonly known as hip replacement surgery, is a highly effective orthopaedic intervention, reducing physical disability and pain symptoms mostly associated with osteoarthritis:[1] the 'orthopaedic operation of the 20th century'.[2] Elective arthroplasty rates (hips or knees) can be used as an indicator of equity of access to care in health systems[3]; the reason for this is multifactorial, highlighting the 'elective' nature of the procedure, over time steady populational demand/need (mostly associated with osteoarthritis) and the well-established surgical approaches with known outcomes.[4]

In high-income countries, the rate of arthroplasties has been increasing over time.[5,6] Studies of population needs and clinical outcomes of the procedure[7] show that healthier and younger patients incur a lower treatment cost than less healthy and/or older patients, as a result of shorter hospital stays and decreased postoperative complication rates.[8] Higher levels of social deprivation are associated with longer travel distances to access orthopaedic care[9] and late surgical intervention with advanced stages of osteoarthritis.[10] Ageing is associated with increased need for intervention in both sexes and across all ethnic groups.[11] Women presenting with adverse hip function scores have a higher prevalence of osteoarthritis but may not receive more arthroplasties than men with similar morbidity;[11] however, when social deprivation is also considered, low rates of, and/or delayed access to, surgical care is observed regardless of gender.[12]

Variations in treatment rates may be due to differences in public and private supply of healthcare services, including beds and staff levels.[13] The utilisation of healthcare depends on need, supply factors and on the price charged for services.[14] Although Brazil is an Upper-Middle Income Country and Scotland a High Income Country, both countries have a public universal health system, free at the point of delivery.[15,16] In his seminal paper on the *Inverse Care*

Law, Tudor Hart[17] highlights how the provision of care is inversely proportional to the need of the population served and 'operates more completely where medical care is most exposed to market forces, and less so where such exposure is reduced'. We investigate this for Brazil and Scotland in relation to hip arthroplasties, analysing and comparing public and market supply factors (beds and physicians) with need.

We analyse and compare trends in national and regional treatment rates for the Scottish National Health System and the Brazilian Unified Health System (SUS) by socioeconomic status and their association with public and private/independent sector, physician and bed supply. Elective hip arthroplasties are used to gauge equity of access to care in middle-income countries.

Methods

Data sources – elective primary hip arthroplasty procedures, bed data and workforce data

(i) Elective primary hip arthroplasty procedures

DataSUS Brazil – the Ministry of Health website publishes all aggregated data on publicly funded hip arthroplasties, by number of procedures and geographical state (there are 26 states in Brazil, plus the Federal District, where the national capital Brasilia is located). Files derived from hospital admission authorisations (AIHs), which are part of this data-set, were used to obtain patient-level data and only individuals over 30 years of age were considered.

Information Services Division Scotland (ISD) – JF applied for patient-level data as these data are not publicly available from NHS Scotland. The public sector in Scotland codes procedures using the Office of Population Censuses and Surveys 4 (OPCS-4) which is comparable to the American Medical Association Current Procedural Terminology (CPT) also applied in Brazil. The application for the data extract comprised all hip replacements in the national database 'General/Acute Inpatient and Day Case dataset' (Coded as SMR01) by OPCS codes of the Scottish Arthroplasty Project (SAP) performed between 2009/10 and 2012/13, divided into age groups (four-year intervals from 30 up to 80 years and older), gender, NHS Board of treatment/residence and Scottish Index of Multiple Deprivation (SIMD) quintile.

(ii) Bed data: Bed returns, private and public

DataSUS Brazil – data on hospital beds are collected monthly by DataSUS from the National Register of Health Services (Cadastro Nacional de Serviços de Saúde – CNES) and are available at the DataSUS website for public access. In Brazil, hospital beds are defined by specialty or clinical services (obstetrics, paediatrics and others).

Information Services Division Scotland – bed data based on midnight returns divided into the following categories: seven day and five day, beds in clinical facilities (e.g. intensive care units), beds in cardiac care units, beds in private rooms and cots in neonatal units.

(iii) Workforce data

Federal Medical Council of Brazil – reports data on the general and specialised medical workforce available in Brazil.

Information Services Division Scotland – spreadsheets, with the number of medical professionals by specialty, financial year and Health Board in Scotland, are available via the service website for download.

(iv) Voluntary private sector coverage

Brazil: National Agency of Supplementary Health – the government agency that regulates the private sector in Brazil publishes data on the number of people enrolled in private healthcare insurance over time and by region.

Scotland: Scottish Official Statistics – reports and crude data available on the Scottish government website.

Data sources – denominators

For Scotland, the mid-year census population of 2009/10–2012/13, given by the General Register Office of Scotland, was used accounting for around 5.3 million people. For Brazilian rates, the census estimates published by the Brazilian Institute of Geography and Statistics (IBGE) for the same period were used and the population was around 202.4 million.

Crude elective primary hip arthroplasty rates per 100,000 people by age group and gender were calculated for both countries, data for those aged 30 years and over. Direct age and sex standardised rates were calculated based on a standard population (the Canadian population in 1991), using a World Health Organisation directive on cross-country comparisons between highly different population profiles;[18] national and regional rates were calculated. In Scotland, the regional division was based on the 14 NHS Health Boards and in Brazil based on five geographic regions.

Total numbers and rates were described nationally, per region and per sector (private or public) in Brazil, and nationally and per NHS board in Scotland.

Sources of bias and limitations

Data from the private/independent sector are incomplete in both countries. In Scotland, the great majority of procedures are publicly funded; however, in Brazil there is no official information/register of privately funded procedures. According to unofficial estimates from the Brazilian Hip Society, around 70,000 hip arthroplasties are performed every year in Brazil, of which only around 17,000 are publicly funded.[19]

There are different coding practices between the two databases. In the Brazilian public sector, at the time of writing, there are five codes for hip arthroplasty (labelled hybrid/non-cemented, cemented, resurface, partial) and one for revision (excluding specification of prosthesis types and specificities of cases). In Scotland, the OPCS-4 coding system uses more than 50 codes for arthroplasty and more than 30 for revisions. The level of medical knowledge regarding chronic osteoarthritis and its treatment standards is similar in both countries, so the differences in coding should not affect the findings.[20] Elective primary hip arthroplasty was considered as a single unit, excluding revisions and including all ways of performing a primary hip arthroplasty. No distinction could be made between surgeons or consultants due to data limitations.

In both countries, administrative data regarding hospital beds are liable to variations due to incomplete electronic records at local level. There are differences in administrative definitions of hospital beds when making cross-country comparisons.

Results

In Scotland, rates increase with age from 30–34 years to 75–79 years, and then decrease in the 80 + age group. In Brazil, the rate in 30 and 40 year olds is close to zero (0.3 per 100,000 people); rates increase from age 40–44 to the 75–79 age group, and decrease in the 80 + group. The highest rate in both countries is in the 75–79 age group; however, the rate for this age group is six times higher in Scotland than in Brazil; for the younger group 30–34 years the rate is nine times higher in Scotland than in Brazil (Table 1).

There is a seven-fold difference in age standardised rates between Scotland and Brazil. The Brazilian rates remain similar over time, while the Scottish rates decreased slightly in 2010/11. Table 1 sets out all standardised rates, with the respective 95% confidence intervals of the estimates for both countries. After standardisation, the difference is attenuated; however, it is still no less than 50/100,000 for the period analysed.

Regional treatment rates in Brazil and Scotland in 2009/10–2012/13

There are regional differences in elective hip arthroplasty rates in both countries (Table 2). Standardised rates in Scotland vary by NHS Health Board. The two highest rates in 2012/13 for Scotland were the remote and rural Shetland and Orkney Islands, with 185.6/100,000 and 172.7/100,000, respectively; however, these regions have very small populations, hence the wide confidence intervals. In populous areas, i.e. the Greater Glasgow and Clyde NHS Health Board (30.4/100,000) and the Lanarkshire NHS Health Board (68.9/100,000), there was a two-fold difference in the rate of elective interventions, between Lothian NHS Health Board (45.8/100,000) and Forth Valley NHS Health Board (89.2/100,000).

In Brazil, although the national rate increased slightly between 2009/10 and 2012/13, from 7.8 to 8.3/100,000, the difference between the North and the South regions increased from 13.2 to 14.8/100,000 (Table 3). The Southeast region has similar rates to the national rate (around 8/100,000); the South region has twice the national rate, and seven times that of the North region.

In 2012, there was a near two-fold difference in treatment rates between the higher performing region in Brazil (South, 17.2/100,000) and the lowest performing NHS Board in Scotland for the same year (Glasgow and Clyde 30.4/100,000). There is a 30-fold difference between the worst performing region in Brazil and the best performing Scottish NHS Board (Brazil – North 2.4/100,000, compared with Scotland – Fife 69.5/100,000).

Table 1. Primary elective hip arthroplasties in Brazil and Scotland – standardised (stand.) rates per 100,000 people in the over-30s population 2009/10–2012/13 (95% confidence interval (CI)).

Country/Category	2009/10	2010/11	2011 /12	2012/13
Scotland stand. rate	61.1 (58.6–63.6)	56.7 (54.3–59.1)	59.1 (56.7–61.5)	57.7 (55.3–60.1)
Brazil stand. rate	7.8 (7.6–8.0)	8.0 (7.8–8.2)	8.0 (7.8–8.2)	8.3 (8.1–8.5)

Table 2. Elective hip arthroplasties in Scotland by NHS Health Board – age and sex standardised rate per 100,000 people in the over-30s population 2009/10–2012/13 (95% confidence interval (CI)).

NHS board	2009/10	2010/11	2011/12	2012/13
Ayrshire/Arran	70.5 (60.2–80.8)	67.8 (57.7–77.9)	59.3 (50.5–68.1)	78 (67.5–88.5)
Borders	97 (76.8–117.2)	130 (104–156.1)	110.5 (87.9–133.1)	206.5 (83–130)
Dumfries/Gal.[a]	114.3 (93.3–135.3)	100.2 (79.9–120.5)	97.7 (80–115.4)	89.6 (71.6–107.6)
Fife	89.5 (83.6–95.4)	78.6 (67.9–89.3)	155.4 (67.4–88)	69.5 (60–79)
Forth Valley	87.6 (75.3–99.9)	85.1 (72.7–97.6)	92.6 (79.3–105.9)	89.1 (76.2–102)
Grampian	48.4 (41.5–55.3)	36.7 (30.8–42.6)	52 (44.9–59.1)	50.6 (43.7–57.5)
Glasgow/Clyde	33.2 (29.2–37.2)	31.6 (27.7–35.5)	36.1 (32–40.2)	30.4 (26.7–34.1)
Highland	78 (62.2–93.8)	70.5 (60.2–80.8)	76.2 (65–87.4)	65.2 (54.9–75.5)
Lanarkshire	65.7 (57.7–73.7)	62.5 (54.7–70.3)	63.1 (55.5–70.7)	68.9 (61–76.8)
Lothian	45 (39.5–50.5)	43.6 (38.2–49)	39.6 (34.5–44.7)	45.8 (40.3–51.3)
Orkney	225.1 (151–299.2)	176.8 (115.5–238.1)	123.8 (74.1–173.5)	172.7 (101.8–243.6)
Shetland	214 (143.9–284.1)	185.3 (117.5–253.1)	216.5 (146.6–286.4)	185.6 (123.1–248.3)
Tayside	64.1 (55.1–73.1)	58.6 (49.9–67.3)	56.1 (47.2–65)	54.8 (46.2–63.4)
Western Isles	182.9 (130.2–235)	142 (94.3–189.7)	195.9 (140.1–251.7)	191.4 (111.9–270.9)
Scotland	61.1 (58.6–63.6)	56.7 (54.3–59.1)	59.1 (56.7–61.5)	57.7 (55.3–60.1)

[a]Galloway.

Table 3. Elective hip arthroplasties in Brazil by geographic area – standardised rate per 100,000 people in the over-30s population in the period 2009/10–2012/13 (95% confidence interval (CI)).

Region	2009/10	2010/11	2011/12	2012/13
South	16.1 (15.4–16.8)	16.1 (15.4–16.8)	16.1 (15.4–16.8)	17.2 (16.5–17.9)
Southeast	7.8 (7.5–8.1)	8.4 (8.1–8.7)	8.5 (8.2–8.8)	9.0 (8.7–9.3)
Centre West	5.7 (5.0–6.4)	5.9 (5.2–6.6)	5.5 (4.8–6.2)	6.8 (6.1–7.5)
Northeast	8.4 (3.9–4.5)	3.9 (3.6–4.2)	5.3 (3.5–4.1)	3.3 (3.1–3.5)
North	2.9 (2.3–3.5)	3.4 (2.8–4)	2.9 (2.4–3.4)	2.4 (1.9–2.9)
Brazil	7.8 (7.6–8)	8.0 (7.8–8.2)	8.0 (7.8–8.2)	8.3 (8.1–8.5)

Analysis: supply factors that might influence public healthcare offer and demand for private care

Private sector

In 2013, 25.3 (12.5%) million individuals of the 200 + million people in Brazil were enrolled in voluntary private healthcare insurance schemes. In 2013, the Southeast region had 38% of the population covered by private health insurance compared with 11% in the North region; there is higher demand for private healthcare in the wealthiest areas of Brazil.

There are no figures available regarding private insurance/out-of-pocket payments for healthcare in

Scotland, only estimates for the United Kingdom as a whole.[21] The purchase of private medical insurance has been in long-term decline, with around 11% of the United Kingdom's population holding some kind of health insurance.[22] This figure might be misleading considering that this kind of coverage is rarely comprehensive,[21] unlike Brazil where most healthcare insurance offers comprehensive coverage.[23]

Trends in hospital beds in Brazil and Scotland

In Brazil, the number of public beds per 100,000 population has decreased since 2009/10 in all regions, with the sharpest decrease in the Centre West region. In Scotland, the numbers of NHS beds and rates per 100,000 population decreased between 2009/10 and 2012/13 in all of Scotland and in all NHS boards, with the exception of Shetland, where there was an overall increase of 15% in the rate of beds per head of population.[24]

The difference in the availability of public hospital beds between Scotland and Brazil is almost two-fold. In Brazil, the rate of beds per 100,000 people in 2012/13 was 168.9, compared with 308.7 for the same year in Scotland (Table 4).

Medical workforce and orthopaedic specialists in Brazil and Scotland

The distribution of medical doctors in Brazil is uneven; the Southeast region has the highest numbers of specialists and non-specialists per head of population coupled with a high rate of specialists, accounting for 64.9% of all registered medical doctors. In 2013, Brazil had 198.8 medical doctors per 100,000, compared to 327.4 in Scotland.

Orthopaedics is the eighth most popular specialty both in Brazil and in Scotland, representing 3.9 and 4.5% of all medical specialists, respectively. In Brazil, the rate of orthopaedic surgeons is 5.2 per 100,000, compared with 4.3 in Scotland for 2013.

Discussion

There were seven-fold differences in the national crude and standardised treatment rates between Brazil and Scotland in the period 2009/10–2012/13, as well as major within-country differences.

About 22.5% of the Brazilian population is enrolled in the private sector, despite the SUS universal public care system.[25] Although the Brazilian data used for this study were from the public sector only (DataSUS), the two regions with lower enrolment rates for private health coverage for 2012 (North 10.4%; Northeast 11.6%) also had lower hip arthroplasty rates in the public sector.

In the North and Northeast regions of Brazil, the percentage of the population relying solely on the public sector for healthcare in 2012 was 89.6% and 88.4%, respectively. The highest percentage of private sector coverage in Brazil is in the Southeast region (37.2% in 2012), where rates of hip arthroplasties are close to the national average.

The Brazilian private sector is estimated to carry out three times more elective primary hip arthroplasties than its public counterpart every year.[26]

The number of private sector hospital beds increased since the start of its unified health service in most regions of Brazil, following the expansion in private health coverage to the population from year 2000 onwards. The sharpest decrease in public hospital beds in Brazil was in the Southeast region, with a decrease of 37.2/100,000 beds, while in the same period the private sector expanded its provision by 8.2% in that region, increasing by 8.6/100,000 beds (82.5/100,000 in 2012/13). This meant 61,320 more beds for the sector in that region alone. In short, in the Southeast, where there was the highest decrease in rate of beds in Brazil, the private sector increased its coverage ratio. In Scotland, the transfer of public funds to the private (independent) sector has been associated with a decrease in public utilisation rates and an increase in socioeconomic inequalities in regards to access to elective hip arthroplasties.[27]

Table 4. Rates[a] of hospital beds in Brazil (SUS and private) and Scotland (NHS only) for 2009/10–2012/13[b] per 100,000 people.

	2009/10	2010/11	2011/12	2012/13	Difference[c]
Scotland	332.1	324.5	314.5	308.7	−23.4
Brazil SUS	177.8	176.4	172.8	168.9	−8.9
Brazil private	63.3	65.5	66.1	66.2	+2.7

[a]Per 100,000 people.
[b]Source: NHS Scotland and DataSUS.
[c]Difference between years 2009/10 and 2012/13.

Notwithstanding the wide differences in procedure rates and public hospital beds, the number of non-specialised medical doctors per head of population is similar: Brazil (92.3/100,000) and general practitioners in Scotland (91.4/100,000) and orthopaedists (5.2/100,000 in Brazil and 6.4/100,000 in the UK); most practise medicine in both sectors in Brazil.[28] The majority of specialists are trained in publicly funded hospitals linked to universities and medical schools (which in Brazil are also, mostly, subsidised by the state). The public health system in Brazil bears the cost of training specialists.[29]

Conclusion

Brazil and Scotland both have regional variations in sex and age standardised hip arthroplasty rates. However, Brazil has 20-fold lower rates than Scotland in some of its regions: The North and Northeast of Brazil had the lowest rates. Both of these are economically vulnerable regions and have been the main targets of federal social programmes of income distribution in the past decade, with some successful health outcomes.[30]

The widely applied and debated 'inverse care law' states that the availability of care tends to vary inversely with the population need, it 'operates more completely where medical care is most exposed to market forces, and less so where such exposure is reduced' (Hart,[17] p.405). The Brazilian case, where there is a concentration of medical workforce and treatment rates in the two wealthiest regions (South and Southeast) is a textbook example.

The influence of the health system setting in Brazil, with two sub-health systems, a public and a private one, does not guarantee access and there is a highly skewed distribution of specialists towards wealthier areas with more private provision.

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ORCID iD: Jonathan Filippon https://orcid.org/0000-0003-3907-1992

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