

# Hip arthroplasty practice across the Organisation for Economic Co-operation and Development (OECD) over the last decade

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## ABSTRACT

**Introduction** There are large variations in the number of hip replacements performed between countries, demonstrating large health inequalities; however, there has been limited research on this variation. The aims of this paper were to compare rates of hip replacements using Organisation for Economic Co-operation and Development (OECD) data for the period 2008–2018. The study also compared changes in the number of hip replacements in the total population and in only those aged over 65, and looked for a correlation of health expenditure and gross domestic product (GDP) with rates of hip replacements.

**Methods** The OECD collects annual data from all member countries on the numbers of hip replacements, healthcare expenditure and GDP. Data analysis was undertaken using STATA. Descriptive statistics and Pearson's correlation coefficient were performed.

**Results** The mean number of hip replacements performed in OECD countries in 2018 was 191.5 per 100,000 population per year. The largest number was 310.6 in Germany and the lowest was 8.6 in Mexico. There has been a 21.7% increase in the mean number of hip replacements across OECD countries. There was a moderate and significant Pearson coefficient of 0.468 ( $p = 0.009$ ) between the number of hip replacements performed per 100,000 population in 2018 and GDP per person, and a strong and significant correlation with health expenditure ( $R = 0.784$ ,  $p < 0.001$ ). There was a moderate correlation ( $R = 0.645$ ,  $p = 0.003$ ) between the percentage change in the number of hip replacements performed per 100,000 population and the percentage change in healthcare expenditure per person between 2008 and 2018.

**Conclusions** There is 36-fold variation in the practice of hip replacements across the OECD and the number of hip replacements has increased by more than 20% over the past decade. The number of hip replacements performed appears to be correlated with health expenditure in each country and may indicate a need that can only be met by increasing health expenditure.

## KEYWORDS

Hip arthroplasty – Incidence – Epidemiology – Health inequalities

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## Introduction

It is estimated that 9.6% of men and 18.0% of women aged over 60 years have symptomatic osteoarthritis.<sup>1</sup> Up to 80% of those with osteoarthritis have limitations in movement, and one-quarter are unable to perform activities of daily living.<sup>1</sup> Hip and knee osteoarthritis are the 11<sup>th</sup> highest contributor to global disability,<sup>2</sup> and this burden will increase as the elderly population increases. It is predicted that 20% of the world's population will be aged over 60 by 2050.<sup>3</sup>

Hip replacements are one of the most successful surgical procedures performed, with reported 10-year failure rates of only 4.56%.<sup>4</sup> Over 100,000 hip replacements are performed per year in the United Kingdom (UK) and this number is increasing<sup>5</sup> with the demand for hip replacements predicted to increase.<sup>6</sup>

The Organisation for Economic Co-operation and Development (OECD) collects annual data from all member countries and aims to establish evidence-based international standards and find solutions to a range of social, economic and environmental challenges.<sup>7</sup>

There is variation in the number of hip replacements performed between OECD countries, demonstrating large health inequalities.<sup>8</sup> However, overall there has been limited research on the variation in surgical practice between countries and over time, as well as the effect that health expenditure has on the number of hip replacements performed.<sup>8</sup> If it is found that the number of hip replacements is increasing over time and with increasing health expenditure this will enable future healthcare planning and allocation of resources.

The aims of this paper are to compare rates of hip replacements using OECD data for the period 2008–2018. This study compares changes in the number of hip replacements in the total population and in those aged over 65. We also aimed to analyse any correlation of health expenditure and gross domestic product (GDP) with rates of hip replacements.

## Methods

Data were collected and analysed with permission from the OECD. The OECD was founded in 1961 and now includes 37 member countries from around the globe. It provides sources of comparative socio-economic data and collects over 5 billion data points annually, including annual data from all members regarding population, GDP, healthcare expenditure and surgical procedures.<sup>7</sup>

Data on surgical procedures are provided by individual countries, for example, NHS Digital from the UK and the Australian Institute of Health and Welfare from Australia.

Data were collected based on the International Classification of Diseases version 9 clinical modification (ICD-9 CM). This allows for the standardisation of data collection between countries. The ICD-9 CM codes for hip replacements are 81.51–81.53 and 00.73–00.77.<sup>9</sup>

Hip replacement numbers are reported annually as total procedures, total procedures per 100,000 population and total procedures per 100,000 population aged 65 years and over. Each country uses slightly different classification systems and registration practices. This may include variations in which countries provide data for total hip replacements and partial hip replacements, and whether the data include private and publicly funded hospitals. The methodology for all countries is consistent and although caution should be used for direct comparisons between countries, variations over time should be accurate.

Healthcare expenditure and GDP are analysed as US dollars per person per year. Healthcare expenditure measures the final consumption of healthcare goods and services including personal healthcare and collective services, but excluding spending on investments. This includes both private and public funding. GDP is the ‘standard measure of the value created through the production of goods and services in a country during a certain time period’. GDP and health expenditure for each country are compared with number of hip replacements performed.

The countries included in this study had provided continuous annual data on the number of hip replacements to the OECD. Countries were excluded if they had not provided any data on hip replacement numbers in the last 5 years, or they had provided fewer than five sets of data in total.

## Statistical analysis

Data analysis was undertaken using STATA (version 15). Descriptive statistics were performed. Ten-year change in numbers of hip replacements, GDP and health expenditure were calculated based on 2008 and 2018 data. If these data were unavailable, data from either the preceding or following year were included. Any countries that did not have data within 1 year were excluded.

Percentage change was calculated based on the change between the values in 2008 and 2018.

A Pearson correlation coefficient was calculated between GDP and number of hip replacements performed in 2018, and between healthcare expenditure and number of hip replacements performed in 2018. This was also calculated for percentage change in healthcare expenditure and percentage change in number of hip replacements performed per 100,000 population. A *p*-value of <0.05 was taken as statistical significance. The correlation was classed as negligible between 0 and 0.09, weak between 0.10 and 0.39, moderate between 0.40 and 0.69, strong between 0.70 and 0.89 and very strong between 0.90 and 1.00.

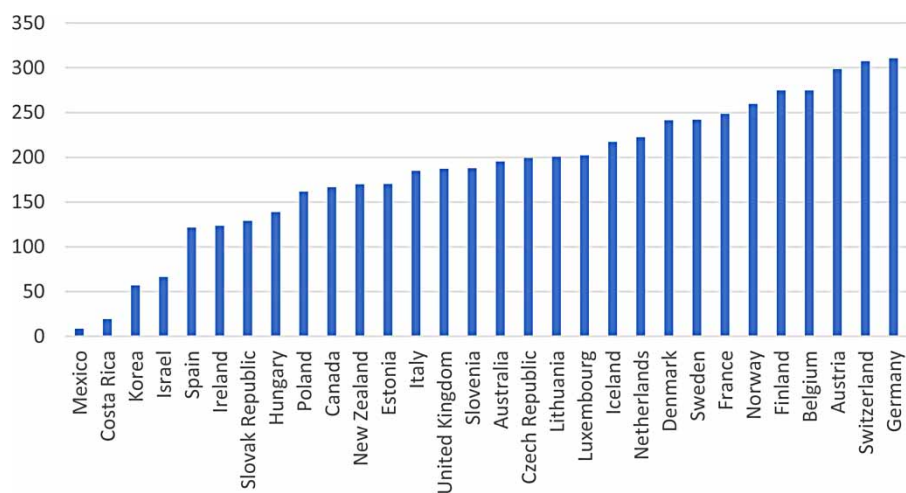
## Results

The mean number of hip replacements performed in OECD countries in 2018 was 191.5 per 100,000 per year (Table 1). The highest number was in Germany with 310.6, followed by Switzerland with 307.3. The lowest was in Mexico at 8.6 (Figure 1). In those aged over 65, Switzerland performed the most hip replacements per person with 1,690 per 100,000 in 2018, followed by Austria at 1,600. Again, the lowest was Mexico at 120 per 100,000 (Figure 2). Data are presented in Table 1.

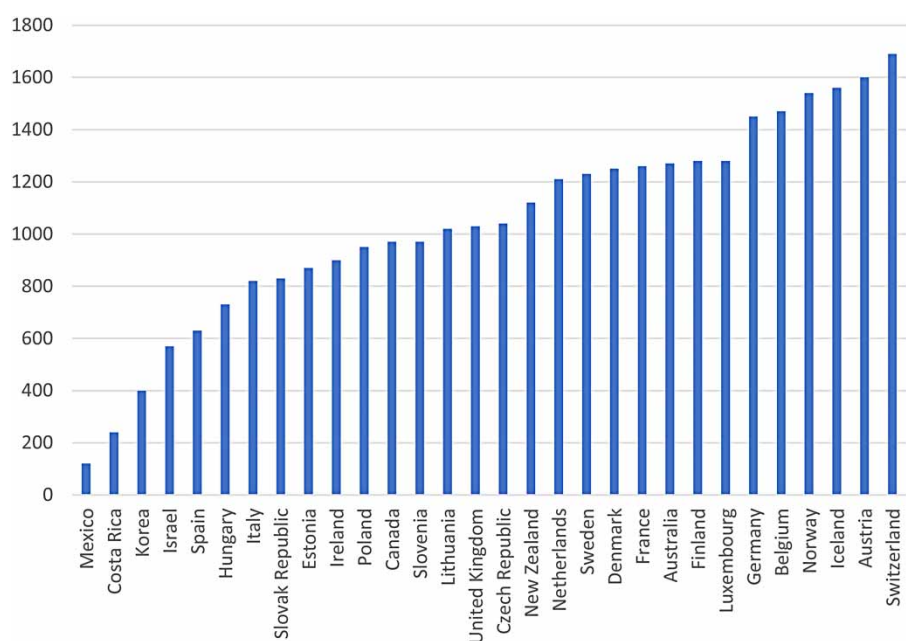
**Table 1** Number of hip replacements performed per 100,000 population in Organisation for Economic Co-operation and Development countries between 2008 and 2018

Year	Observations	Mean	sd	Min	Max
2008	26	157.3	78.1	7	292
2009	27	153.1	73.6	7.2	282.6
2010	28	150.3	73	7.3	283.9
2011	28	155.8	71.7	7.5	289.8
2012	29	159	71.8	7.7	287.4
2013	30	160.5	74.4	7.8	282.9
2014	31	169.5	75	8	299.8
2015	29	174.1	72	8.1	305
2016	29	185.5	73.5	8.2	313.7
2017	29	190.6	73.3	8.4	309.4
2018	26	191.5	78	8.6	310.6

sd = standard deviation



**Figure 1** Total procedures per 100,000 population per country in 2018



**Figure 2** Total procedures per 100,000 population over 65 by country in 2018

Across all OECD countries there has been a 21.7% increase in the mean number of hip replacements performed per 100,000 population from 157.3 in 2008 to 191.5 in 2018.

The number of hip replacements performed by population increased in the majority of countries. Although the numbers overall increased in all countries for which data from between 2008 and 2018 could be

analysed, many countries saw a smaller increase in hip replacements in those over 65, with many slightly decreasing the number of hip replacements performed in this population. The percentage increase in hip replacements overall across OECD countries per 100,000 population was 25.3% between 2008 and 2018, but was only 8.1% in those aged over 65 (Figure 3).

Health expenditure per person varies considerably between countries with the United States of America (USA) spending \$10,528.48 per person in 2018, compared with Mexico which has the lowest expenditure at \$1,116.03 per year (Figure 4). Two countries, Greece and Luxembourg, have seen a decrease in health expenditure per person per year, whereas all the other countries have seen an increase (Figure 5).

Comparing the number of hip replacements performed per 100,000 population in 2018 with GDP (\$) per person in 2018 there was a moderate and significant Pearson coefficient of 0.4683 ( $p = 0.0091$ ) (Figure 6). There was a strong and significant correlation between health expenditure per person and the number of hip replacements ( $R = 0.784$ ,  $p < 0.001$ ) (Figure 7).

When comparing the percentage change in the number of hip replacements performed per 100,000 population and the percentage change in healthcare expenditure per person between 2008 and 2018 there was a moderate correlation ( $R = 0.645$ ,  $p = 0.003$ ). When looking at the change in the number of hip replacements performed in those aged over 65 and the change in health expenditure, there was also a moderate correlation ( $R = 0.616$ ,  $p = 0.001$ ) (Figure 8). For change in GDP and change in the number of hip replacements the correlation was not significant ( $R = 0.3487$ ,  $p = 0.747$ ).

## Discussion

The burden of hip osteoarthritis is likely to increase with an ageing population. The prevalence of hip osteoarthritis is over 400 million worldwide, with an increase of 35.3% between 2007 and 2017.<sup>10</sup> The lifetime risk of total hip replacement has been found to range between 6.3% and 15.9%, and has been increasing over past decades.<sup>11,14</sup>

This study found wide variation in practice across the OECD and that all countries are performing an increasing number of hip replacements over a 10-year time frame. This is also true when analysing the number of hip replacements performed in those aged 65 and over, which counteracts the effects of differing age demographics in different countries. Variations in the number of hip replacements performed in OECD countries was previously reported in the 1990s.<sup>15</sup> As well as differing numbers of hip replacements, previous studies found national differences in demographics, surgical techniques and implants.<sup>16</sup>

Hip replacements are known to improve patient quality of life more than any other elective procedure.<sup>15</sup> Although the financial burden of hip replacements is high, the cost per quality-adjusted life year (QALY) is relatively low at between \$1,500 and \$10,402.<sup>17,19</sup> The National Institute for Health and Care Excellence in the UK sets the recommended cost per QALY at between £20,000 to £30,000, but this threshold varies between countries.<sup>19,21</sup> Hip replacements have also been shown to lead to other healthcare cost savings compared with non-operated individuals.<sup>17</sup> The fact that there is a relationship between health expenditure and the number of hip replacements performed indicates a potential unmet demand in the treatment of hip osteoarthritis. Therefore,

Number of hip replacements performed per 100,000 in 2008 and 2018

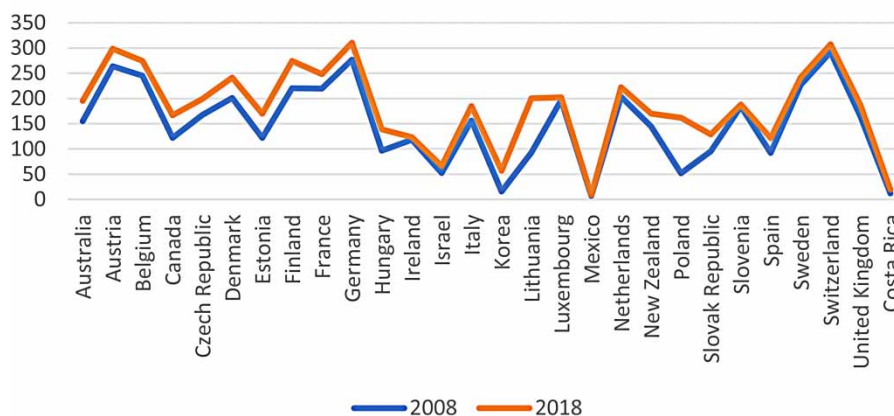
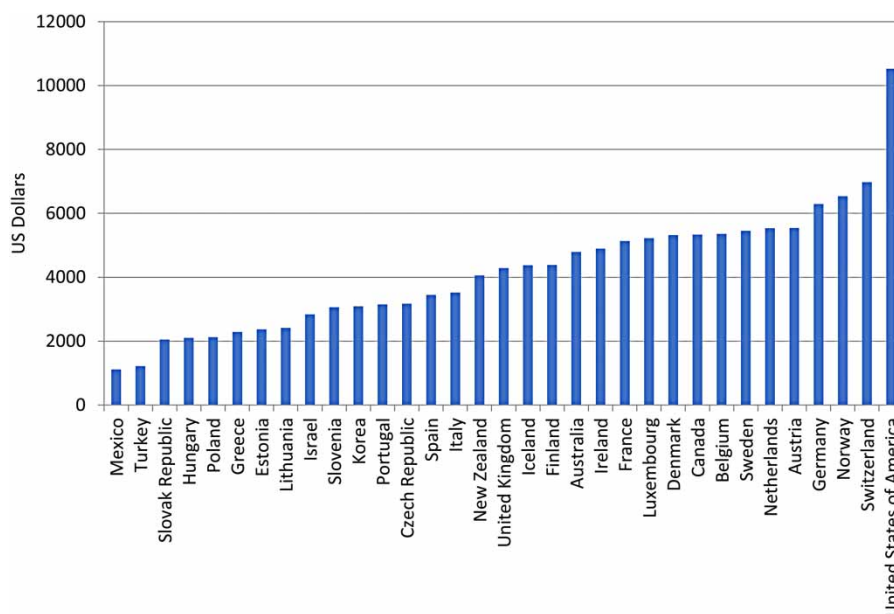


Figure 3 Percentage change in the number of hip replacements in people aged over 65 and in the total population



**Figure 4** Health expenditure per person (US dollars) in 2018

there may be many patients who are potentially not receiving hip replacements due to a lack of resources. As health expenditure continues to increase it is likely that the number of hip replacements performed will also.

The majority of primary hip procedures are carried out on an elderly population, and there has been an increase in the number of hip replacements performed in the past decade in most OECD countries. The median age in the England and Wales National Joint Registry (NJR) is 69, with an interquartile range of 61–76 years; median age in the Australian Registry is 67.7 years.<sup>5,22</sup> There was minimal change in the proportion of patients aged 55–64 years undergoing hip replacement between 2003 and 2018, and the numbers of patients aged below 60 in the NJR represent fewer than 20% of the joint replacements undertaken; this number has remained relatively unchanged over the past decade.<sup>5,22</sup> Some studies predict that those aged over 65 will account for over 50% of hip replacements in the future, but these changes were not found in this study.<sup>5,6,23</sup>

As well as national differences, there are likely to be variations within countries. Geographical and socio-economic variations have been reported in several countries.<sup>24,27</sup>

Predictions of future hip replacement numbers vary widely. Between 2018 and 2050, primary hip replacement is predicted to increase by between 41.9% and 114.3% in France, and by 174% between 2005 and 2030 in the USA.<sup>28,29</sup> Our data, which reflect actual changes over 10 years, appear to demonstrate a more conservative estimate. In other words, over the decade

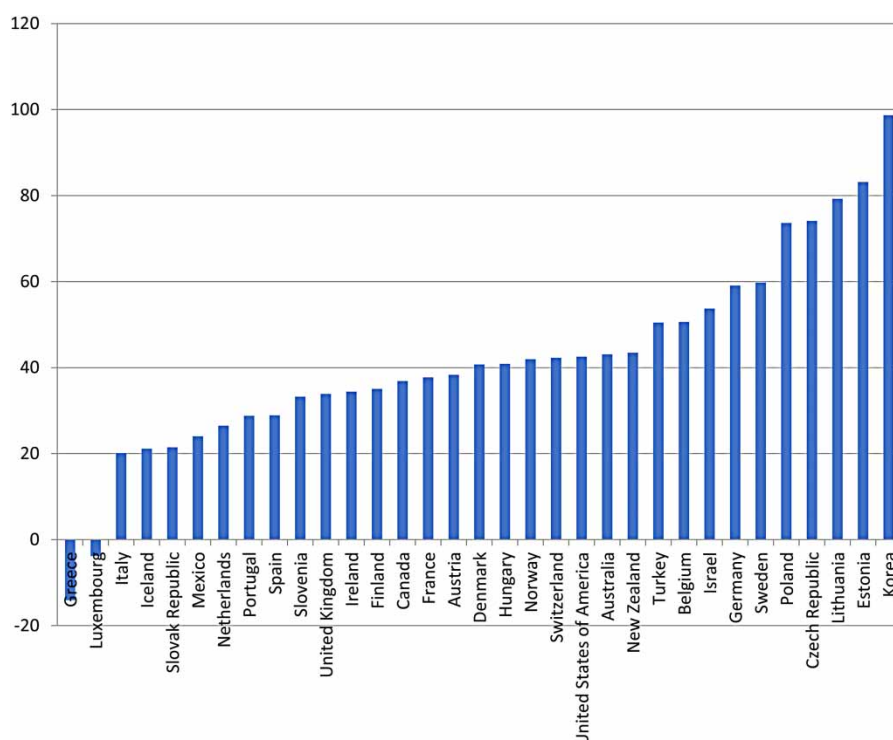
2008–2018, the increase in hip replacements in France was 13.1%.

The world's population reached 7.7 billion in mid-2019 and is expected to increase to 9.7 billion in 2050 with variation between OECD countries. For the first time in 2018 those aged over 65 outnumbered children aged under 5 worldwide.<sup>30</sup> An increasing elderly population will increase the disease burden of osteoarthritis and the need for hip replacements in the future, as can be seen by the higher numbers of hip replacements performed in over 65s compared with all ages.<sup>31</sup> These demographic changes will likely increase the demand for hip replacements in all countries in the future.

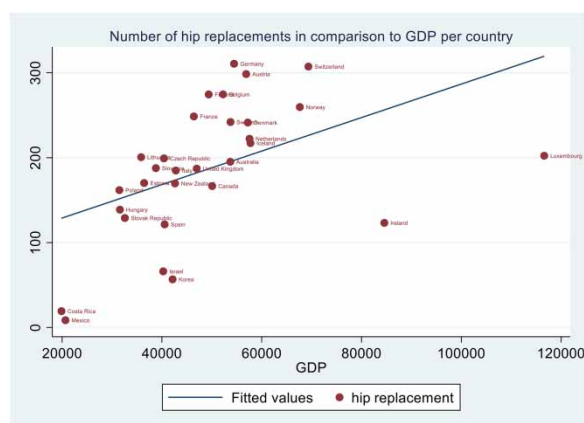
The percentage increase in hip replacements overall per 100,000 population was considerably higher than for those aged over 65. As we understand the longevity of hip replacements, it is possible that more procedures are being performed on younger patients, confident in the knowledge that over half will last 25 years.<sup>4</sup> It may also be a sign that rationing of health resources is occurring due to the health economics of an increasingly elderly population. Although it is impossible to state the exact reason for the differences, it is likely to be multifactorial.

This study found large variations in health expenditure between countries, with the USA (highest) spending over eight times per capita the amount spent in Mexico. The number of hip replacements was found to be associated with an increase in health expenditure. This indicates that there may be an unmet demand in the undertaking of hip replacements, and that with increasing resources

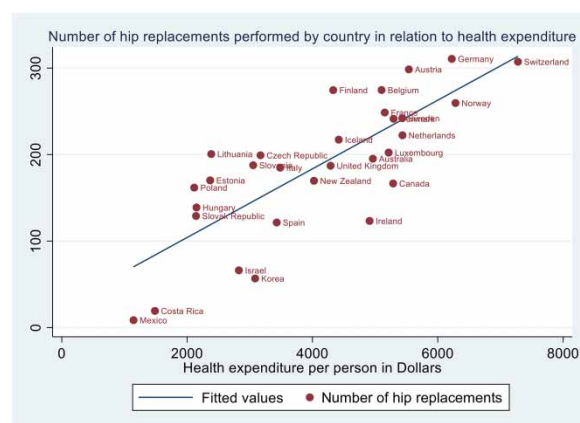




**Figure 5** Percentage change in health expenditure per person between 2008 and 2018



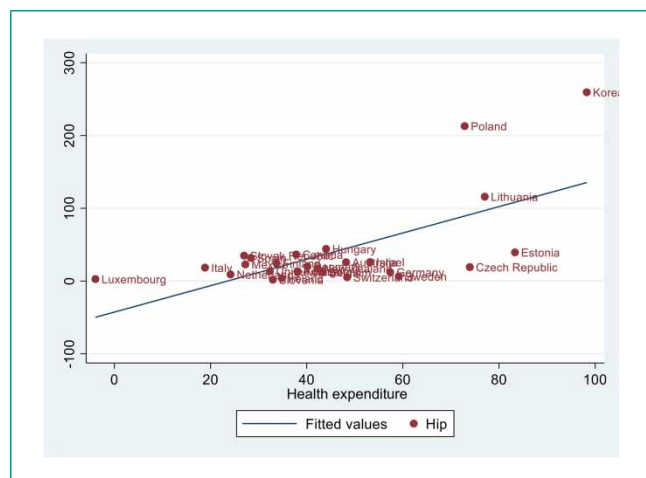
**Figure 6** Comparison of number of hip replacements performed per 100,000 population and gross domestic product per person



**Figure 7** Comparison of number of hip replacements performed per 100,000 population and healthcare expenditure per person

more patients will receive the hip replacements they require. It should be noted that following the financial crisis of 2007, there was a slight decrease in the number of hip replacements performed across OECD countries, but a large proportion of this could be accounted for by

Greece, which was hit particularly hard by this financial crisis. A further study in the USA also found that economic downturns did not substantially influence national growth trends.<sup>25</sup> This study analysed only those countries reporting data to the OECD and did not



**Figure 8** Comparison of change in number of hip replacements performed per 100,000 population and change in health expenditure per person between 2008 and 2018

include many developing nations that may have even greater variations in the number of hip replacements performed and health expenditure.

### Study limitations

A limitation when using large databases is the accuracy of the data. The OECD is an international organisation that uses its data for international policy and therefore it can be presumed that the data are as accurate as is possible with large datasets. However, countries may report hip replacements differently or use a variety of ICD-9-CM codes. Wengler *et al*<sup>52</sup> found a rate of 284 per 100,000 population in Germany in 2011 compared with 276.7 recorded by OECD. Wengler *et al* used nationwide inpatient statistics (DRG statistics) which covered 17.7 million of the population. The nationwide inpatient sample, which is representative of 20% of US hospitals, found a rate of 149 compared with 183 recorded by the OECD.<sup>52</sup> A further limitation is the lack of information on number of hip replacements by gender. There may also be variations between countries in the data provided and the procedures included.

Another limitation is that the data only include a small number of countries worldwide, and not countries with large populations such as the USA, China, India, Russia, Brazil, Indonesia and South Africa. The data do not include numbers from the continents of Africa or South America. There are currently multiple representative samples in the USA, but these all produce differing numbers.

### Conclusions

There is a 36-fold variation in the practice of hip replacements across the OECD. The number of hip

replacements has increased by more than 20% over the past decade in OECD countries. The number performed appears to be correlated to the health expenditure of each country. This may indicate a need that will only be met by increasing health expenditure.

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