Manning Laurens (Orcid ID: 0000-0003-4334-5351)

A high prevalence of older Australians with one or more joint replacements: estimating the population at risk for late complications of arthroplasty

Laurens Manning, PhD [1,2] , Joshua S Davis, PhD [3,4], Owen Robinson, FRACP [2], Ben Clark, FRACP [2], Michelle Lorimer MSc [6], Richard de Steiger, FRACS [5,7], Stephen E Graves, FRACS, [5,8].

1. Faculty of Health and Medical Sciences, University of Western Australia, Harry Perkins Research Institute, Fiona Stanley Hospital, Murdoch, Western Australia
2. Infectious Diseases Department, Fiona Stanley Hospital, Perth, Western Australia.
3. Global and Tropical Health Division, Menzies School of Health Research, Darwin, NT, Australia
4. Department of Infectious Diseases, John Hunter Hospital, Newcastle, NSW, Australia
5. Australian Orthopaedic Association National Joint Replacement Registry, Adelaide South Australia
6. South Australian Health and Medical Research Institute, Adelaide South Australia
7. Department of Surgery, Epworth Healthcare, University of Melbourne, Melbourne, Victoria, Australia
8. University of South Australia, Adelaide, South Australia

Corresponding author

Dr Laurens Manning, Faculty of Health and Medical Sciences, University of Western Australia, Harry Perkins Research Institute, Fiona Stanley Hospital, PO Box 404, Bull Creek

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6149, Western Australia, Australia. Tel +61 8 61611156. Email:

laurens.manning@uwa.edu.au

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Abstract

Background: To provide an estimate of the population at risk for late complications of arthroplasty, we aimed to determine the prevalence of Australians living with one or more joint replacements.

Methods: Data included all arthroplasty procedures performed in Australia from 2003 to 2016 recorded by the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). The age- and gender specific Australian population was obtained from the Australian Bureau of Statistics and used as denominator data. Survival data for each joint replacement, and of individuals, was used to estimate the arthroplasty prevalence. Analyses by age, gender and joint replacement site were undertaken. Prevalence estimates were augmented with procedural data captured before 2003 modelled with assumptions accounting for age and gender distributions, overall survival and arthroplasty revision rates.

Results: By the end of 2016, there were 824,769 Australians living with at least one joint replacement, representing 3.4% of the total population. The prevalence of joint replacement is increasing in all age groups, but was highest amongst older Australians, with an overall prevalence of 22.5%, and 13.3% in those aged >85 years and 65-84 years, respectively. The

prevalence of people living with multiple joint replacements is increasing more rapidly than patients who have undergone only one joint replacement procedure.

Conclusion: The prevalence of older Australians living with joint replacements is rapidly increasing, providing an estimate of the population-at-risk for late complications of arthroplasty including peri-prosthetic infection and fracture.

Background

Over 100,000 joint replacements are performed in Australia each year. The rate of joint replacement continues to increase in Australia by 73.7% for hip replacements, 111.5% for knee replacement since 2003, and 115.5% for shoulder replacements since 2008 (1). The Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) monitors and records the effect of multiple factors that influence the outcome of joint replacement procedures (2). Registry data can be used to estimate the prevalence of people living with a joint replacement *in situ*.

Knowledge of the prevalence of joint replacement is important because it provides an estimate of the population at risk of serious late complications including, but not limited to, prosthetic joint infection (PJI) and peri-prosthetic fractures which can result in substantial morbidity, hospitalisation and cost to the health sector (3, 4).

In this study, we aimed to determine the prevalence of Australians living with at least one joint replacement according to age, gender, site and the number of joint replacements for each individual. Knowledge of such data might refine estimates of the projected burden of Australians presenting with PJI, peri-prosthetic fracture and other late complications in the future.

Methods

The Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) commenced data collection on 01 September 1999, achieving complete national implementation by mid-2002. Since then it has collected data on almost 100% of hip and knee arthroplasties performed in Australia (1). Full national collection of shoulder replacements did not occur until 2008 (although some shoulder procedures were captured from 2004 onwards). These data are validated against patient-level data provided externally by all Australian state and territory health departments. A sequential, multilevel matching process is used to identify any missing data which are subsequently retrieved by contacting the relevant hospital. Each month, in conjunction with internal validation and data quality checks, all primary procedures are linked to any subsequent revision involving the same patient, joint and side. Data are also matched bi-annually with the Australian Government's National Death Index (NDI) to obtain information on the date of death. Linking revision and death to the primary procedure enables revision rates to be determined.

To determine prevalence, two datasets were used. The first was AOANJRR data from 2003 to 2016. As there are patients still living who had joint replacement prior to 2003, AOANJRR

data was augmented with government data from 1994 to 2002. Data prior to this period was not available. We used the dates, together with the joint side and site of primary and revision procedures to calculate the total number of hip, knee and shoulder arthroplasties *in situ* for each individual recorded in the Registry by year. Denominator data for the Australian population at the end of each year according to age, and gender were obtained from the Australian Bureau of Statistics for the period 2003 to 2016 (5). For estimates of the prevalence of arthroplasties *in situ* implanted prior to 2003, we used pre-registry government data that only captured procedures performed by financial year from 1994-2003 (6). These data weren't matched to NDI and no patient demographics were available. It was therefore assumed that the age and gender distribution of arthroplasties performed pre-registry were the same as that after 2003. It was also assumed that the overall revision rate of arthroplasties performed during this period was 10% and that subsequent revisions would be captured by the registry data from 2003. The probability of these patients surviving in each year from 1994 to 2016 were estimated using life tables from the ABS (5). The prevalence of pre-2003 arthroplasties at each year were added to the totals captured by the registry to provide an augmented estimate of total arthroplasty prevalence for joint replacements performed from 1994.

Ethics

The AOANJRR is a declared Commonwealth of Australia Quality Assurance Activity under section 124X of the Health Insurance Act, 1973. All AOANJRR studies are conducted in accordance with ethical principles of research (the Helsinki Declaration II).

Results

By December 31st 2016, there were 677,804 Australians living with at least one hip, knee or shoulder joint replacement *in situ* that had been inserted since 2003. From 2012 to 2016, there was a 41% increase in the prevalence of people living with joint replacement. By contrast, there was a 23% increase in the number of arthroplasty operations performed annually during the same time period (Figure 1). By the end of 2016, 2.8% of the total Australian population were living with a joint replacement inserted between 2003-16.
It is estimated that when the registry began capturing complete nationwide data in 2003, there were already 297,320 patients with a joint replacement *in situ* inserted between financial years 1994/5 and 2002/3. By 2016, 146,965 of these patients remained alive with the original arthroplasty still *in situ*. When augmented with this estimate pre-2003 arthroplasty operations, at the end of 2016 there were 824,769 Australians living with at least one arthroplasty, representing 3.4% of the total population. The proportion of joint replacements that had been inserted pre-2003 represented 21.7% of the total (Figure 1).

The prevalence of joint replacement increases with age. By the end of 2016, there was a higher prevalence of joint replacements implanted in the years 2003-16 amongst people aged >85 years (22.5%), than the 65-84 years (13.3%), 45-64 years (2.3%), 25-44 years (0.1%), or <25 years (0.01%) age groups (Figure 2).

The prevalence of joint replacements implanted from 2003-16 is higher than females than in males (3.1% versus 2.5%, respectively). In 2016, of those people with at least one joint replacements *in situ*, 392,290 individuals had hip replacements, 311,402 had knee replacements and 29,273 had shoulder replacements. The prevalence of Australians with at least one knee replacement is increasing over time at a faster rate than hip or shoulder replacements (Figure 3).

The prevalence of Australians living with more than one joint replacement implanted from 2003-16 is increasing more rapidly rate than in those with only one joint replacement (Figure 4). By 2016, there were 24,182 Australians living with ≥3 joint replacements *in situ*, and 43 people with all of their hips, knees and shoulders replaced.

Discussion

These data confirm a rapid increase in the overall prevalence of Australians with joint replacements *in situ*. The striking finding of this study is the high prevalence of joint replacement amongst older Australians with 22.5% of those aged >85 years and 13.3% of those aged 65-84 years living with at least one joint replacement.

One of the strengths of this study is the use of Registry data, which captured procedural-level data from 2003-2016 which was validated against national, state and territory government health department and NDI patient-level data. The validated Registry data could then determine the prevalence of patients currently living with at least one arthroplasty *in situ*. In a comparable study from the United States of America (USA), relative differences in mortality

rates and the rates of subsequent operations on the ipsilateral and contralateral joints were determined at the procedural-level, but were not linked to individual patients (7). This study estimated the arthroplasty prevalence as 2.3% of the USA population in 2010, a finding that accords with the present study where prevalence was 2.7% in 2010 and 3.4% in 2016. In a similar pattern to the present study, older adults had higher arthroplasty prevalence in 2010 with 6.7% in those aged 60-69 and 15.8% 80-89 years, respectively. Using data from the present study to allow comparison with data available from the USA, arthroplasty prevalence for older Australians was 13.1% in 2010.

The joint replacement prevalence estimates were strengthened by accounting for joint replacements performed prior to 2003. Modelled estimates suggest that ~22% of Australians living with at least one joint replacement in 2016 had their arthroplasty operation performed pre-2003. It is expected that the relative contribution of pre-2003 joint replacements will continue to decrease as patients in this group die, have their prosthesis revised or have a new joint replacement that will be captured in the AOANJRR.

The modelled estimates of joint replacement operations performed pre-2003 have limitations. Due to the fact that only procedural numbers were available, assumptions were made relating to age and sex distribution, mortality and prosthesis revision rates. Errors in these assumptions will clearly affect the estimates of this proportion of the total. Furthermore, we were unable to discriminate patients with a joint replacement pre-2003 who subsequently

were included in the registry with a primary arthroplasty operation in another joint. This could potentially lead to a slight overestimation of the total prevalence.

Due to the intrinsic limitations in the assumptions made for pre-2003 estimates, only accurate registry data for the prevalence of joint replacements according to age, gender, joint and total number of joints were calculated and presented. Although this means that the prevalence estimates at the end of 2016 according to each of these factors are based on accurate patient-level data, they do not account for the less refined pre-2003 data and therefore are likely to represent underestimates of the true prevalence.

Knowledge of the prevalence of joint replacement is important because it provides an estimate of the population at risk of serious late complications including, but not limited to, prosthetic joint infection (PJI) by estimating the population at risk for this late complication. Deep infection complicates 1-2% of new arthroplasties within 2 years, fewer than half of which present in the early post-operative period, and the remainder are delayed (8-10). Early post-operative complications such as PJIs will be expected to rise at a rate proportional with the increase in the total numbers of arthroplasty operations performed. By contrast, increases in the population at risk for haematogenous infection will contribute to a higher proportion of PJI occurring as a result of blood stream infections.

Such data might enable more accurate assessments of the total burden of PJI in Australia. For example, *Staphylococcus aureus* is the commonest cause of PJI and is also a common cause

of blood stream infection; amongst patients with *S. aureus* bacteraemia and joint replacements *in situ*, ~40% can be expected to develop a PJI (11). Like joint replacement, *S. aureus* bacteraemia is also more common in older patients with an annual incidence of 20/100,000 across the entire population and >100/100,000 persons aged over 70 (12). Taken together, as the Australian population ages, there is likely to be a convergence of increasing blood stream infection amongst an older population amongst those with a high prevalence of joint replacement.

In conclusion, there is a high, and increasing prevalence of joint replacement in the Australian population, particularly in older age groups. This has important implications for estimating the risk and economic burden of serious late complications associated with joint replacement.

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Potential conflicts of interest. All authors report no conflicts of interest relevant to this article.

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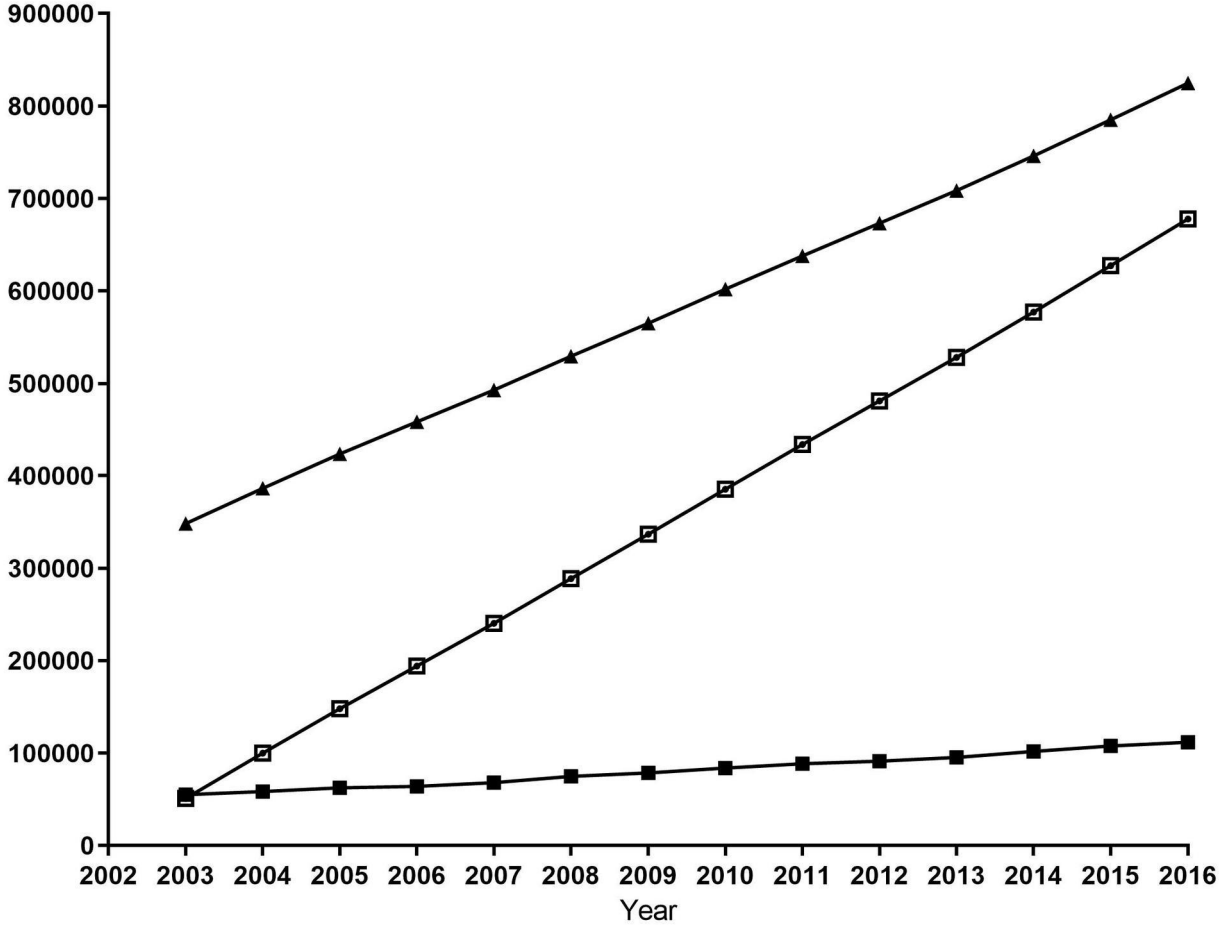
Figure 1. Total number of Australians living with at least one arthroplasty from 2003-2016. The total annual estimates for each year include arthroplasty operations captured by the Australian Orthopaedic Association National Joint Replacement Registry from 2003 (solid line), estimates of the prevalence of people living with arthroplasties performed after 2003 (dashed line) and total annual estimates for arthroplasties augmented with estimates of procedures performed 1994-2003 (grey line).

Figure 2. The prevalence of Australians living with at least one joint replacement from 2003-2016, according to age.

Figure 3. The prevalence of Australians with at least one joint replacement from 2003-2016, according to site

Figure 4. Total numbers of Australians with one or multiple joint replacements in situ from 2003-2016. Panels labelled 1-6 represent Australians living with 1-6 arthroplasties, respectively.



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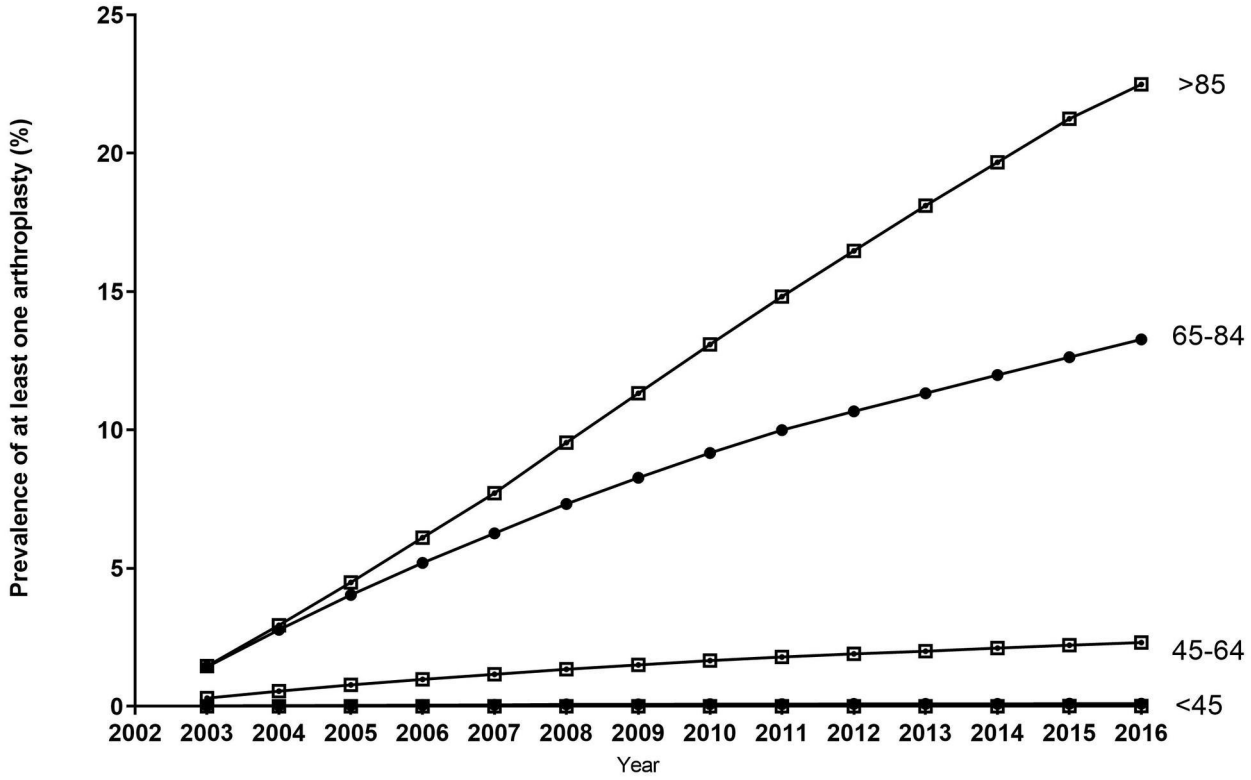

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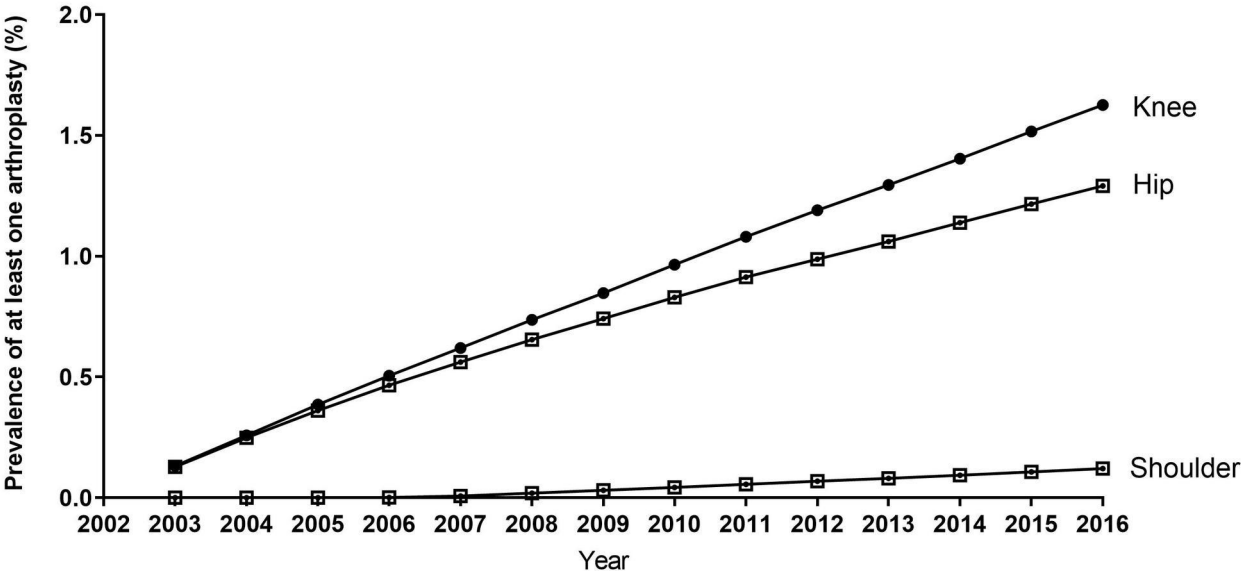

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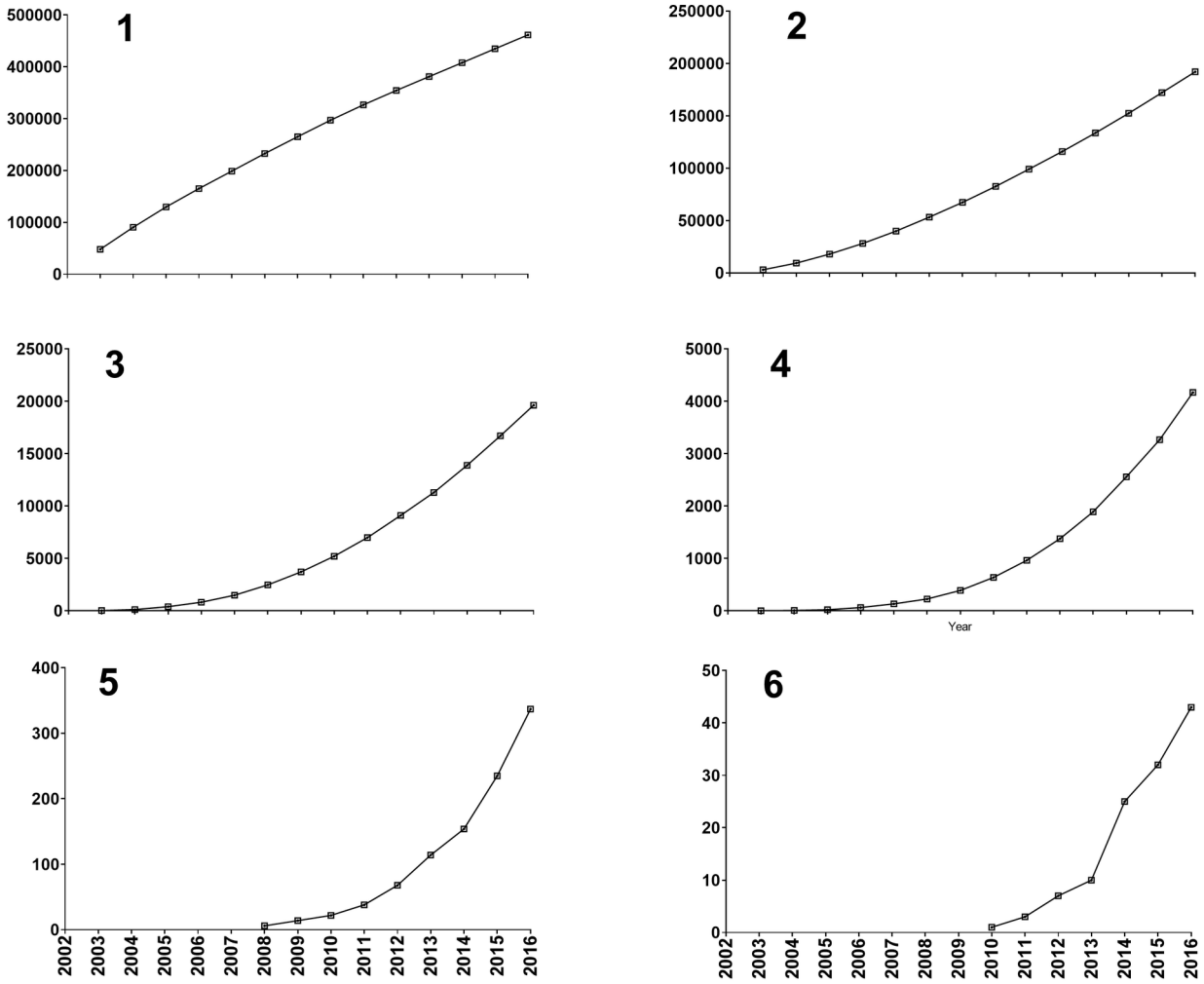

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