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Catalan Arthroplasty Register. Third report (2005-2014)

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Agència de Qualitat i Avaluació Sanitàries de Catalunya

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Any parties interested in this document should contact:
Agency for Health Quality and Assessment of Catalonia. Roc Boronat, 81-95 (second floor).
08005 Barcelona (Spain). Tel.: +34 93 551 3888 | Fax: +34 93 551 7510 | http://aquas.gencat.cat

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Catalan Arthroplasty Register. Third report (2005-2014)

Authorship

Laia Domingo Torrell[1,2], Jorge Arias de la Torre[1,3], Olga Martínez Cruz[1], Mireia Espallargues Carreras[1,2]

On behalf of the Executive Commitee and the Advisory Commitee of the RACat.

Affiliation:

1. Agència de Qualitat i Avaluació Sanitàries de Catalunya (AQuAS)

2. Red de Investigación en Servicios de Salud en Enfermedades Crónicas (REDISSEC)

3. Consorcio de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBERESP)

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Head of Quality and Assessment Department, AQuAS Researcher, AQuAS Administrative assistant-technician, AQuAS	Mireia Espallargues Laia Domingo Olga Martínez Cruz

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Abstract

Background and objectives

The Catalan Arthroplasty Register (RACat, for its acronym in Catalan) is a population-based register designed to assess the clinical effectiveness of hip and knee arthroplasties in Catalonia. The objectives of this report are 1) to present the results corresponding to the period 2005-2014, in terms of volume, completness and quality of the information, as well as the temporary evolution of the arthroplasties and the variability per centre; 2) to describe the characteristics of patients undergoing a knee or hip arthroplasty, along with fixation techniques, models, and characteristics of the implants; and 3) to analyse the survival of knee and hip prosthesis in the short(at 1 year), mid- (at 5 years), and long-term (at 9 years).

Methodology

The RACat population comprises all insured citizens by Catalan Health Service (CatSalut) who underwent hip or knee arthroplasty in a healthcare centre run by the Integrated Healthcare System of Public Healthcare Network of Catalonia (SISCAT, for its acronym in Catalan). The current report covers the period between January 2005 and December 2014. During this period 53 of 61 centres participated in a voluntary basis, sending data to the RACat. By using a secure platform integrated in the Health Registers platform (RSA) of the CatSalut, hospitals sent data on patients, implants, interventions and surgical techniques. This information is complemented with data from the Central Register of Insured Persons (RCA, for its acronym in Catalan), which provides information on the patient's date of birth, place of residence, and vital status. Then, data is linked to the Minimum Basic Data Set at Hospital Discharge (MBDSHD) and the prosthesis catalogue. A descriptive analysis of the volume of arthroplasties included in the RACat per year and period (2005-2006; 2007-2008; 2009-2010; 2011-2012; 2013-2014), hospital, and healthcare region was carried out. The completeness of the RACat data was calculated per year and was compared against participating centres by means of a funnel plot. To assess the quality of the data we computed the percentage of primary knee and hip arthroplasties that were identified following the classification system used in the RACat and the percentage of cases sent to the RACat with the operated side informed. The characteristics of patients (sex, age, reason for surgery, comorbidities), the characteristics of the arthroplasties (type of arthroplasty, fixation technique, friction device) and the most frequently used models, were all described. The cumulative revision rate for knee and hip arthroplasties was estimated for partial and total procedures, by type of fixation and per type of arthroplasty, and by different time intervals: 0 to 30 days, 30 to 90 days, 90 days to 1 year, 1 to 3 years, 3 to 5 years, 5 to 7 years and 7 to 9 years. Cox proportional-hazard regression models were fitted to explore the effects of different factors in the revision arthroplasties adjusted by different covariates.

Results

Knee arthroplasties

- During 2005-2014, the RACat recorded a total of 60,192 primary knee arthroplasties and 6,689 revision knee arthroplasties. The highest completeness was reached in 2011,

showing a slight decrease over the latter period, coinciding with technical changes in data notification. In the latter period (2013-2014), the percentage of arthroplasties that were classified was 81.9% and the percentage of those with reported laterality available was 99.9%.

- In the time period spanning between 2013 and 2014, the mean age of patients undergoing a total and partial knee arthroplasty was 72.3 and 66.8 years, respectively. Osteoarthritis was the main reason for intervention both for total and partial procedures (98.7% and 96.9%, respectively) and mechanical complications were the main cause for revision both for total and partial knee arthroplasties.
- Total knee procedures represented 97.0% of knee arthroplasties, whereas partial knee arthroplasties accounted for 3.0%. Within total knee arthroplasties, the most common arthroplasties were the ones that preserve the posterior cruciate retaining (CR) and the posterior stabilized ones (PS), representing 46.0% and 51.7%, respectively. Among partial knee procedures, unicompartmental arthroplasties were the most common type (82.9%). A 75.7% and 81.5% of total and partial knee arthroplasties were cemented, with a similar distribution per periods, sex, and age groups.
- During 2005-2014, a total of 137 models (counting separately the cemented and cementless models) were identified. The number of models used by the participating hospitals ranged from 1 to 38, with an average of 12 models per hospital.
- The cumulative revision rate for total knee arthroplasties was 0.98%, 3.84% and 5.17% at 1-, 5- and 9-years follow-up, respectively, whereas the cumulative revision rate for partial knee arthroplasties was 2.07% at 1-year and 10.24% at 5-years follow-up. For total knee arthroplasties, an increased risk of revision for patients under 65 years and for patients aged between 65 and 75 years compared to those aged 85 years or over was observed (HR=3.34 (IC95%: 1.96-5.70); HR=2.02 (IC95%: 1.19-3.43), respectively).

Hip arthroplasties

- During 2005-2014, the RACat recorded a total of 46,488 primary hip arthroplasties and 5,237 revision hip arthroplasties. The highest completeness was reached in 2011, showing a slight decrease over the latter period. In the last period (2013-2014), the percentage of arthroplasties classified was 77.1% and the percentage of those with reported laterality was 97.6%.
- In the 2013-2014 time period, the mean age of patients undergoing a total and partial hip arthroplasty was 68.5 and 84.4 years, respectively. Osteoarthritis was the main reason for intervention for total procedures (81.7%), whereas fracture was the reason for intervention in 95.6% of partial procedures. Mechanical complications were the main cause for revision both for total and partial hip arthroplasties.
- Total hip procedures represented 77.6% of hip arthroplasties, whereas partial procedures accounted for 22.4%. Over 95% of total hip arthroplasties were total conventional implants. Within partial hip arthroplasties, bipolar and unipolar monoblok were the most common types, representing a 46.7% and 47.2%, respectively. The proportion on cementless arthroplasties was 64.4% and 50.5% in total and partial hip procedures, respectively. In conventional total hip arthroplasties, the most commonly used friction device was metal-polyethylene (65.8%). Small heads (<32mm) were commonly used among metal-polyethylene, ceramic-polyethylene, and metal-metal implants (72.7%, 68.1% and 43.3%, respectively). Medium heads (32-36mm) were mostly common among ceramic-ceramic arthroplasties (71%).
- During 2005-2014, 1,114 models of stem-socked combinations were identified. The number of acetabular models used by the hospitals ranged from 1 to 34, with an average of 16 per hospital. As for stem models, the number ranged from 1 to 33 with an average of 15 models per hospital.

- The cumulative revision rate for total hip arthroplasties was 1.29%, 2.99% and 4.57% at 1-, 5- and 9-years follow-up, respectively, whereas the cumulative revision rate for partial hip arthroplasties was 1.23%, 2.11% and 2.38%, respectively. For total hip arthroplasties, an increased risk of revision was observed for patients under 65 years, patients aged 65-75 years, and patients between 75-85 years compared to those aged 85 years or over (HR=2.87 (CI 95%: 1.47-5.61); HR=2.38 (CI 95%: 1.22-4.65); HR= 1.96 (CI 95%: 1.00-3.84). A similar trend was observed for partial hip arthroplasties for patients aged 65-75 years and 75-85 years (HR=2.81 (CI 95%: 1.78-4.45; HR=1.63 (CI 95%: 1.21-2.20)). The Cox model considering the different friction devices and adjusted by age, sex, and comorbidities revealed an increased revision rate for metal-metal prosthesis in comparison to metal-polyethylene prosthesis (HR=1.43 CI 95%: 1.06-1.93).

Conclusions

The results presented in this report provide an overview of the quality of RACat's data, the characteristics of arthroplasties carried out in Catalonia over the last 10 years, and the clinical effectiveness of primary knee and hip arthroplasties up to 9 years of follow-up. Although the volume and quality of data recorded in the RACat presented a positive trend over time, there is significant variability per centre, which indicates room for improvement in the process of data acquisition and the need for defining strategies aimed at ensuring better quality reporting. In terms of clinical effectiveness, the results presented are consistent with the international literature. In our context, the RACat is being consolidated as a useful tool to analyse variations in patient characteristics and prosthesis utilization among hospitals or health regions in Catalonia, and may become a powerful system for post-market surveillance of implants. Improvements in data quality, the incorporation of new variables,the continuing increase of the follow-up period, along with consistently working closely with clinicians and key stakeholders, will enable to perform more robust and meaningful analysis that hopefully can foster improvements for the healthcare system.

PRESENTATION

The Catalan Arthroplasty Register (RACat, for its acronym in Catalan) was launched in 2005 in response to a common interest of the Catalan Health Service (CHS), the Catalan Society of Orthopaedic Surgery and Traumatology (SCCOT, for its acronym in Catalan), and the Agency for Health Quality and Assessment of Catalonia (AQuAS, for its acronym in Catalan). The RACat is a population-based register designed to assess the clinical effectiveness of hip and knee arthroplasties in Catalonia. Using the CHS Information System, publicly funded hospitals sent information to the RACat on knee and hip arthroplasties, including patient identification, hospital, joint (hip/knee), type (primary/revision), side of operation, date of surgery, and implants. The information is complemented by linking this data with other databases with the aim to complete the patient's information, clinical procedures, and patient follow-up. The RACat was made possible thanks to the cooperation of professionals and participant centres, along with the collaboration of manufacturers, which help with complementing implant information.

The 2005-2014 Hip and Knee Report is based on the analysis of 118,606 primary and revision knee and hip arthroplasties recorded by the Catalan Arthroplasty Register (RACat) with a procedure date up to and including 31 December 2014. It provides an update of the results presented before incorporating certain new aspects in comparison with previous reports. Firstly, the results for knee arthroplasties are presented separately for total and partial arthroplasties. This differentiation provides a more accurate characterization of the implant outcomes and patient characteristics. As had been the case in previous reports, the results for hip arthroplasties are also presented by total and partial arthroplasties. Secondly, giving the increase of the follow-up period, we are able to show survival outcomes up to 9 years of follow-up. Nevertheless, the number of cases with long term follow up is relatively small for some subgroups, so these figures must be interpreted with caution when reading the current report. Lastly, we have incorporated information on head size for total conventional hip arthroplasties. This data provides a more complete overview for the characterization of hip implants and represents an opportunity to generate further analyses.

1. INTRODUCTION

As has been the case in most European countries, increases in degenerative illnesses due to the population ageing and changes in indication criteria, has led to a significant rise in the number of hip and knee arthroplasties in Catalonia in recent years[1-4]. Although these surgeries are among the most cost-effective medical procedures, significant variability in the clinical practice, along with waiting list problems and a high impact on healthcare budget have been highlighted[5].

After 10 years of operation, the RACat has been consolidated as a useful tool for information, evaluation, and guidance in clinical practice in Catalonia, and has also provided relevant data for professionals, public health bodies and manufacturers. In the context of Spain, , the RACat is a pioneering initiative that will be very valuable if a nationwide registry is eventually launched. On an international level, the RACat adds to more than 50 arthroplasy registers that are currently underway around the world, and collaborates with several networks on a European and global level.

This report aims to provide updated information on knee and hip arthroplasties carried out in publicly funded Catalan hospitals between 2005 and 2014. In the following pages, you will find data on quality and completeness of the information, patient's and implant characteristics, and prosthesis survival in the short, medium, and long-term.

2. OBJECTIVES

The objective of this report is to present the results of the information sent to the RACat during the period 2005-2014 regarding the characteristics of patients, arthroplasty interventions and implanted prostheses, along with the implant survival, and factors related with a better/worse prognosis of the primary hip and knee arthroplasties.

The specific objectives are:

1. To describe data sent to the RACat in terms of completeness and quality of the information, as well as the temporary evolution of the arthroplasties and the variability per centre.
2. To describe the characteristics of patients undergoing a knee or hip arthroplasty, the fixation techniques, models, characteristics of the implanted prostheses and trends over time.
3. To analyse the survival of knee and hip prosthesis in the short(at 1 year), medium (at 5 years), and long-term (at 9 years).

3. METHODOLOGY

3.1. Study population

The study population comprises all insured citizens by Catalan Health Service (CHS) who underwent hip or knee arthroplasty between January 2005 and December 2014 in a healthcare centre run by the Integrated Healthcare System of Public Healthcare Network of Catalonia (SISCAT, for its acronym in Catalan). During this period 53 of 61 centres participated in a voluntary basis, sending data to the RACat. They represented over 85% of the activity that took place in the public sector in Catalonia. So far, RACat does not routinely gather data from private centres, but some centres have begun to adapt their information systems to RACat requirements.

The information provided in this report concerns the characteristics of primary arthroplasties given that they represent the majority of interventions, versus revisions.

3.2. Data collection and sources of information

The RACat database is integrated in the Health Registers platform (RSA) of the CHS that includes a Web Service interface with other office applications, and is accessed through the Applications Portal of Health Department via on-line or Web Services. By using this platform, we ensure the secure transmission of data.
Hospitals sent patient data to the RACat on implants, interventions and surgical techniques. The quality of the information sent to the RACat is reviewed periodically. The results of the review process are sent to the members of the Technical Group of each centre to correct errors; the validated information is sent back to the RACat.

Data provided by centres are: a) patient's Personal Identification Code (PIC); b) date of admission; c) date of intervention; d) date of discharge; e) joint (knee or hip) f) whether it is a primary or a revision arthroplasty; g) operated side (right or left); h) name of the manufacturer; i) reference number and batch number of every prosthesis component informed.

Based on the patient identifier data, the register data are linked with other data sources (Table 1).

Central Insurance Register (RCA, for its acronym in Catalan). This is the register for persons covered by CHS, and provides information on the patient's date of birth, gender, place of residence, and status (death, alive or living outside Catalonia). Using the IIN sent by each centre, the information from the RCA is gathered with data sent by hospitals.

Minimum basic data set for hospital discharge (MBDSHD). This dataset provides information on the reason for intervention, the procedures performed and comorbidities. This dataset is provided by the CHS Activity Register Division.

Catalogue of prostheses. This is produced by the RACat and is based on information provided by manufacturers and distributors of prostheses. This catalogue made possible to complete the information sent by hospitals about implants (name of the manufacturer, reference number, batch number of all components implanted and the cement used), and to identify the type of

component, the fixation technique, the friction device (in total hip arthroplasties), whether fixed or mobile-bearing is used (in total knee arthroplasties), the prosthesis models implanted and to group the type of arthroplasty following the RACat's classification system (Table 2).

We are currently updating several variables included in the Catalogue related to prosthesis design, material, fixation, and component size. This information would allow us to carry out more detailed analysis and would enrich the current results. So far, the catalogue of prostheses offers information on more than 28,000 reference numbers pertaining to the primary components of hip prostheses (stem, acetabulum, insert and head) and knee (femoral, tibial, tibial insert, patella) of 67 manufacturers.

Table 1. ***Variables collected from RACat's source information***

Variables sent by hospital	Variables RCA	Variables MBDSHD	Catalogue of prostheses
• Personal Identification Code (PIC) • Centre • Clinical history number (CHN) • Date of admission and discharge* • Date of intervention • Type of arthroplasty (primary, revision) • Join (knee, hip) • Operated side (right, left) • Prosthesis information (manufacturer, reference and batch number)	• IIN • Sex • Date of birth • Status patient • Basic health unit • Health sector • Health care region	• IIN • Centre • CHN • Date of admission / discharge • Health care region • Sex • Principal / secondary diagnosis (reason for surgery; comorbidities) • Principal procedure • Hospital stay • Discharge from social and health services centres • Level of hospital complexity	• Manufacturer • Reference number • Trademark / brand name • Joint type • Type of implant • Design • Modularity • Mobility • Fixation • Fixation surface • Bearing surface (MoP, PoC, CoC, MoM) • Size • Side

Data of discharge is available from November 2013 onwards

RCA: Central Insurance Register; MBDSHD: Minimum basic data set for hospital discharge; MoP: Metal on Polyethylene; PoC: Polyethylene on Ceramic; CoC, Ceramic on Ceramic; MoM: Metal on Metal.

RACat's surgical form. A surgical form was agreed by the Catalan Society of Orthopaedic Surgery and Traumatology (SCCOT, for its acronym in Catalan). This form includes information on the patient, surgery, intervention, implants and intraoperative complications[6]. Since the end of 2013, the variables of the surgical form have been integrated into RACat's information System. Some hospitals have started to report the variables of this form, but we are still in the implementation phase.

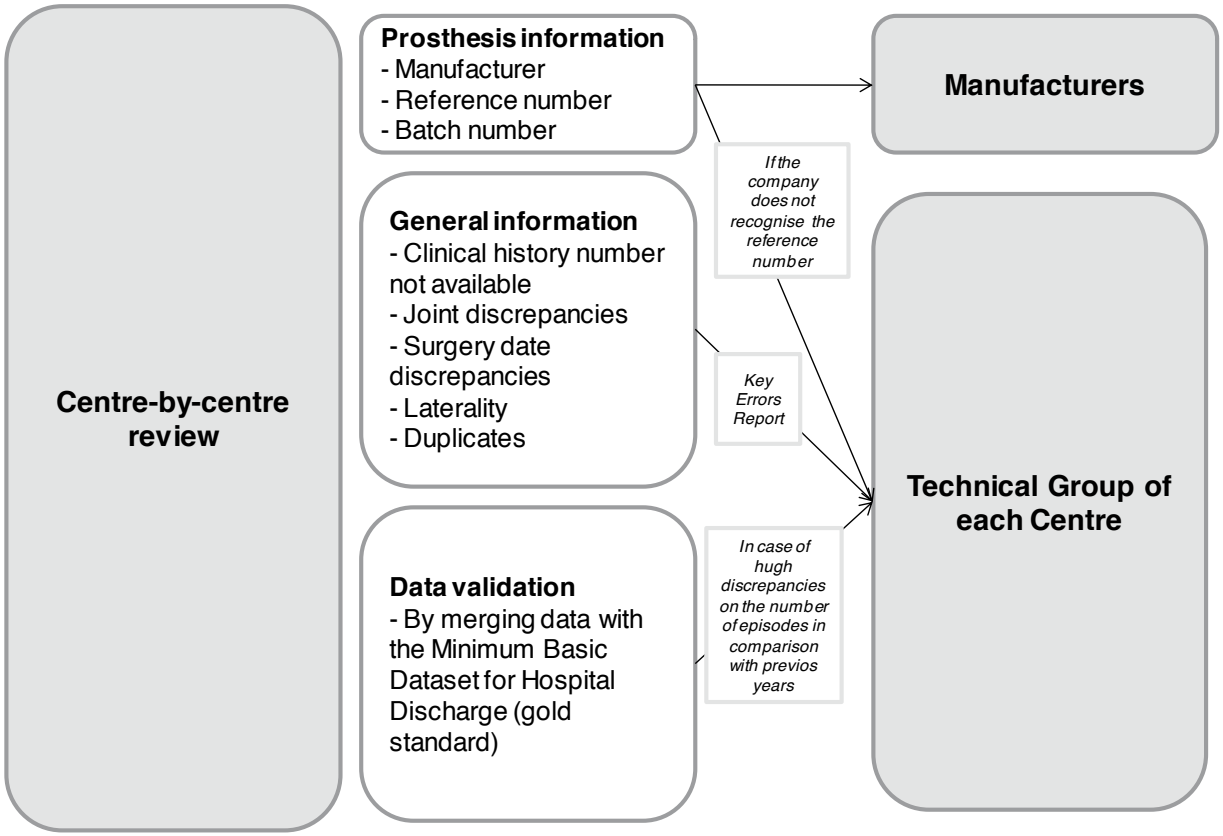
3.3. Data protection and confidentiality

The RACat is part of the CHS Information System, guaranteeing compliance with the applicable regulations on data protection (RD994/1999, of June 11; organic Law 15/1999, of 13 December; RP 428/1993, of 26 March) and ensuring that the information is transmitted via secure communication. In accordance with legal regulations in force, data is anonymised to carry out specific analysis.

3.4. Quality control and data validation

The quality of the information sent to the RACat is reviewed periodically. As part of the review process, we check the information related to prosthesis, patients, and arthroplasties. The data review circuit is detailed in Figure 1.

Figure 1. ***Data review circuit***



3.5. Primary arthroplasty classification system

In order to group the different types of arthroplasties implanted, centres must send the necessary information regarding prosthesis components. RACat uses the classification system showed in Table 2, which was adapted from the Australian Orthopaedic Association National Joint Replacement[7].

Primary knee arthroplasties

The knee joint is divided into three major compartments: patellofemoral, medial and lateral femorotibial joint. The type of arthroplasty is defined depending on the number of compartments replaced (Table 2): a) Partial knee arthroplasties: when one or two compartments are replaced (patellofemoral and/or femorotibial). b) total knee arthroplasty (TKR), when two or three compartments are replaced. Within partial knee arthroplasties we differentiate between: unicompartmental (UKA), when a single compartment is replaced (medial or lateral tibiofemoral); bicompartmental, when the medial or lateral and patellofemoral compartments are replaced;

and patellofemoral, if only this compartment is replaced. Furthermore, total arthroplasties are classified into different groups, depending on the joint range of motion and whether cruciate and collateral ligaments are preserved or not: cruciate retaining (CR), cruciate substituting or posterior stabilized (PS), constrained, hinged and tumoral (in these latter two categories collateral ligaments are not preserved).

Primary hip arthroplasties

Two large groups of arthroplasties have been defined: partial and total arthroplasty, when a part or all of the joint is replaced, respectively: a) partial hip arthroplasty (PHA), if femoral joint is replaced, and b) total hip arthroplasty (THA) when acetabulofemoral joint is replaced (Table 2). In addition, partial arthroplasties are grouped as: unipolar monoblock when only a stem is implanted, unipolar modular, when a stem and a cephalic component is implanted, and bipolar, where a stem and a bipolar head component are implanted. In the case of total arthroplasties, they are grouped as: conventional, when a stem, head and acetabulum are implanted; resurfacing, when a large head and cup are implanted and the femoral head is not removed; Dual mobility acetabular component (also known as unconstrained tripolar implant) when a dual-articulation acetabular cup is used; and with short stem, when a short stem, head and acetabulum are implanted.

Table 2. ***Classification system for primary hip and knee arthroplasties***

Type of arthroplasty	
Knee	**Hip**
Partial knee arthroplasty (PKA)	**Partial hip arthroplasty (PHA)**
Patellofemoral	Unipolar monoblock
Unicompartmental femorotibial (UKA)	Unipolar modular
Bicompartmental	Bipolar
Total knee arthroplasty (TKA)	**Total hip arthroplasty (THA)**
Cruciate retaining (CR)	Resurfacing
Posterior stabilised (PS)	With short stem
Constrained	Conventional
Hinged	Dual Mobility o tripolar
Tumoral	

3.6. Statistical analysis

The analyses were structured in three areas, in line with the proposed objectives: quality and completeness of the data, descriptive analyses and survival analyses.

Completeness and quality of the information

To analyse the quality of the data and the completeness of the information, the information from the RACat and the Minimum Basic Data Set at Hospital Discharge (MBDSHD) was considered. To this end, the analysis accounted for all patients covered by CHS who received a knee or hip arthroplasty in one of the centres collaborating with the RACat (n=118,606) from January 2005 to December 2014, including 66,881 knee arthroplasties and 51,725 hip arthroplasties. We only considered the public activity carried out in Catalonia over the study period.

MBDSHD is a comprehensive clinical and administrative database on all health and morbidity activity conducted in public and private hospitals in Catalonia. Thus, the activity of the 53 hospitals participating in the RACat is recorded herein. We used this database as a gold standard to calculate the completeness of the RACat. The information of both registers was linked together using the patient's IIN, centre, admission date, joint, and type of arthroplasty (primary or revision).

A descriptive analysis of the number of arthroplasties (**volume**) included in the RACat per year and period (2005-2006; 2007-2008; 2009-2010; 2011-2012; 2013-2014) was carried out. The completeness of the RACat's data, per centre and year, was calculated. **Completeness** was considered to be the ratio between the arthroplasties volume sent to the RACat and the arthroplasties volume sent to the MBDSHD by participating hospitals during the 2005-2014 period. A funnel plot between the completness of each centre and the case volume sent to the RACat, in an anonymized way, was plotted. To do this, the overall completeness of all participating centres of the RACat with a 95 % confidence interval was used as a reference.

Two indicators were defined to assess the **quality of the data**: the percentage of primary knee and hip arthroplasties that were identified following the classification system used in the RACat (Table 2) and the percentage of cases sent to the RACat with the operated side informed (right or left). A funnel plot for each indicator with the result of every centre and the case volume sent to the RACat, was also anonymous. It was used as a reference for the overall result with a 95 % confidence interval.

The funnel plot is recommended as a visual aid to benchmark centres. In this type of graph, an estimate of an indicator versus an interpretable precision measure is drawn. The limits of control draw the shape of a funnel over the objective result control. In the case of centres that are above or below the limits of control, the value of the indicator will be interpreted as being above or below the set or target outcome.

Descriptive analyses of patients and arthroplasties

To perform the descriptive analyses, all cases in which there was correspondence between the data from the RACat and the MBDSHD were selected, thus ruling out 6.8% of cases. This meant a total selection of 110,618 arthroplasties (61,565 knee arthroplasties and 47,428 hip arthroplasties).

For each type of joint (hip and knee), a descriptive analysis was carried out (first by overall data and then by health care regions) of the patient characteristics (volume, sex, age and type of arthroplasty). At the same time, and only for those patients included in the RACat and linked with the MBDSHD, other questions related to morbidity and the care delivery process were described (reason for surgery, comorbidities, hospital stay and percentage of referrals to a convalescence centre at hospital discharge).

The **global burden of revision**, the percentage of revisions sent to the RACat compared to total number of interventions sent (primary and revisions), was calculated. This index provides the percentage of revisions undertaken in a given period in relation to the total number of interventions. In contrast with the cumulative revision rate, revision procedures described in the burden revision during 2005-2014, do not necessarily correspond to patients who underwent a primary arthroplasty in the same period (it is a cross-sectional cut without a follow-up).

Fixation technique (cemented, uncemented and hybrids) and the type of arthroplasty used were described per age group and period; and, in the case of conventional hip arthroplasties, the **friction device** (metal-metal, metal-polyethylene, ceramic-polyethylene and ceramic-ceramic) was also described overall and per age group. The five most common **implant models** have been described by type of arthroplasty and fixation technique.

Information on **head size** among conventional hip arthroplasties was also analysed. This variable was groped in 3 categories: small heads, if the head diameter was <32mm; medium heads, when the head diameter ranged between 32 and 36 mm; and large heads, when the head diameter was >36mm.

Implant survival analysis

As for the survival analyses, these excluded not only cases where there was no data link between the RACat and the MBDSHD, but also cases where the side (right or left) could not be determined, and cases in which information was received about the revision surgery but not about the primary surgery. As a result, these analyses covered a total of 46,406 knee arthroplasties and 31,603 hip arthroplasties.

A survival analysis was conducted considering the time elapsed from the primary arthroplasty until the revision of the prosthesis, irrespective of the reason for revision. A revision arthroplasty was defined as any procedure involving removal, exchange or addition of any implant part.

Cases were censured at the date of death, at the date of discharge from Catalonia to other Spanish autonomous communities or foreign countries (patients no longer affiliated to the CHS) or at 31st December 2014 if no event occurred before the end of the study, whatever occurred first.

The **cumulative revision rate** for knee arthroplasties was estimated for partial and total procedures, by the type of fixation and according to the type of arthroplasty. For hip arthroplasties, differentiated analyses were carried out for partial and total procedures. For the latter ones, the cumulative rate by friction device was also considered. When calculating the cumulative revision rates, the actuarial adjustment by the number of patients at risk of replacement was considered for each time interval.

To find out the revision rates at short-term or to year basis, the following intervals of time were used: 0 to 30 days, 30 to 90 days, 90 days to 1 year, 1 to 3 years, 3 to 5 years, 5 to 7 years and 7 to 9 years.

On the other hand, Cox proportional-hazard regression models were fitted to explore the effects of different factors in the revision arthroplasties adjusted by different covariates[8]. The hazard ratio (HR) of revision was estimated depending on the type of fixation, adjusted by patient age and sex. These models allow considering the elapsed time until the event or the censorship, with proportional risk assumption. The reading of a HR corresponds to that of a relative risk. Therefore, a HR>1, where 1 is not included in the 95% confidence intervals (CI), measures how high the risk for replacement in patients with the factor is, in relation to the ones that do not have it.

In order to adjust the analyses by risk of patient death, we also fitted Cox proportional-hazard models for competing risks of Fine and Grey[9].

4. KNEE ARTHROPLASTIES RESULTS

4.1. Scope and quality of data

In the period described, data from 60,192 patients with primary arthroplasty and from 6,689 patients with revision knee arthroplasty were received. As shown in Figure 2 and Table 3 the volume of data increased over the first three periods in most health regions, suffering a slight decrease from 2012 onwards.

Table 4 shows the volume of primary and revision arthroplasties sent during the study period, per centre. The overall burden of revisions, understood as the percentage of revision arthroplasties compared to the total number of events sent, was 10.0%. Remarkable disparities were found between centres with a minimum burden of 0% and a maximum of 24.8%.

Figure 3 shows the completeness by type of knee arthroplasty (primary or revision) over the years. It can be observed that the highest completeness both for primaries and revisions was reached in 2011. A gradual decrease was observed from 2012 onwards, coinciding with technical changes in data notification. Figure 4 shows the variability in data completeness of each centre (blue points) compared with overall completeness (green line) and a confidence interval based on overall completeness. The centres that are below the range of the confidence interval exhibit lower completeness compared to the overall figure, and the ones that are above exhibit higher completeness than the overall. Only 9 out of the 53 centres fell below the confidence interval based on the overall reference value.

As a quality indicator of data, we calculated the percentage of arthroplasties that had been classified following the RACat's classification. Considering the whole period, the percentage of classified primary arthroplasties was 82.2% (Table 5). Figure 5 is a funnel plot showing the percentage of classified primary arthroplasties per centre in relation to the volume of data sent in the period 2013-2014. As can be seen, almost all the healthcare centres present percentages around 80%, which indicates good data quality of the information sent.

The percentage of arthroplasties with reported laterality increased over the study period reaching 99.9% in 2013-2014 (Table 6). Considering data from the latter 2 years we plotted percentage of laterality reported per centre (Figure 6). Here we can see that all centres reported correctly this variable correctly in 2013-2014.

Figure 2. ***Volume of knee arthroplasties sent to the RACat per year, and by type of arthroplasty. Source RACat***

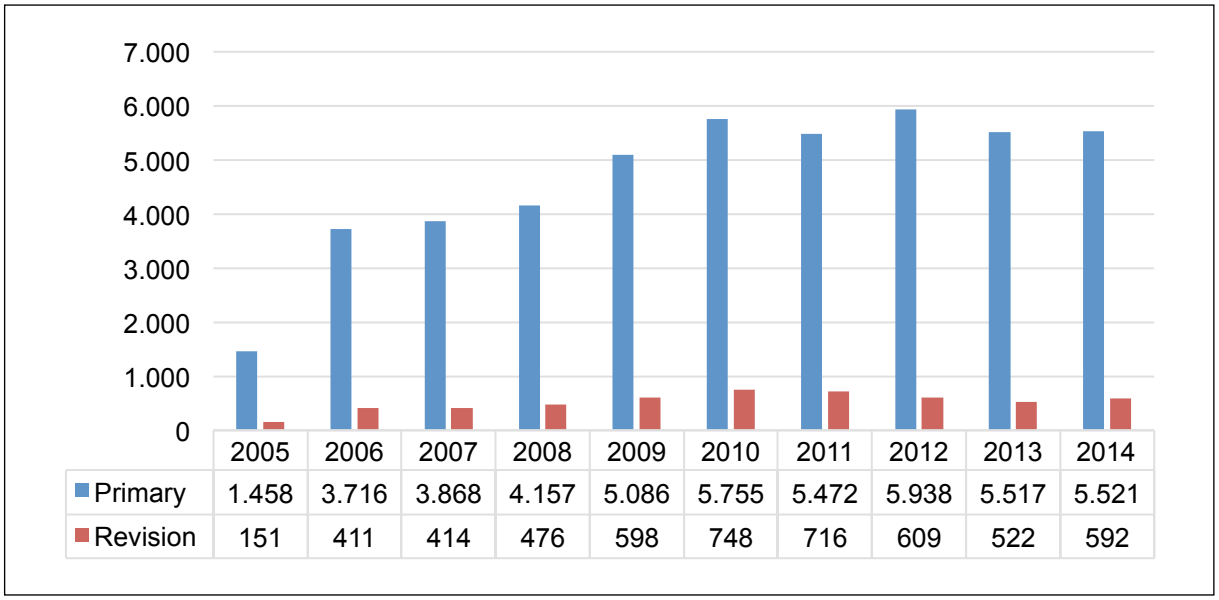


Table 3. ***Number of knee arthroplasties by health region period and by type of arthroplasty. Source RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
Lleida	216	15	515	31	604	48	640	27	798	8	**2,773**	**129**
Camp de Tarragona	129	3	817	30	1,157	46	1,014	31	1,017	65	**4,134**	**175**
Terres de l'Ebre	0	0	0	0	637	59	400	36	305	48	**1,342**	**143**
Girona	1,190	83	1,511	118	1,829	169	1,496	159	1,687	102	**7,713**	**631**
Catalunya central	615	43	1,137	93	1,218	176	1,164	200	1,282	153	**5,416**	**665**
Alt Pirineu i Aragó	97	3	116	0	135	3	134	6	124	0	**606**	**12**
Barcelona	5,576	476	7,491	773	9,239	1,189	8,317	1,079	7,585	1,417	**38,208**	**4,934**
Total	**7,823**	**623**	**11,587**	**1,045**	**14,819**	**1,690**	**13,165**	**1,538**	**12,798**	**1,793**	**60,192**	**6,689**

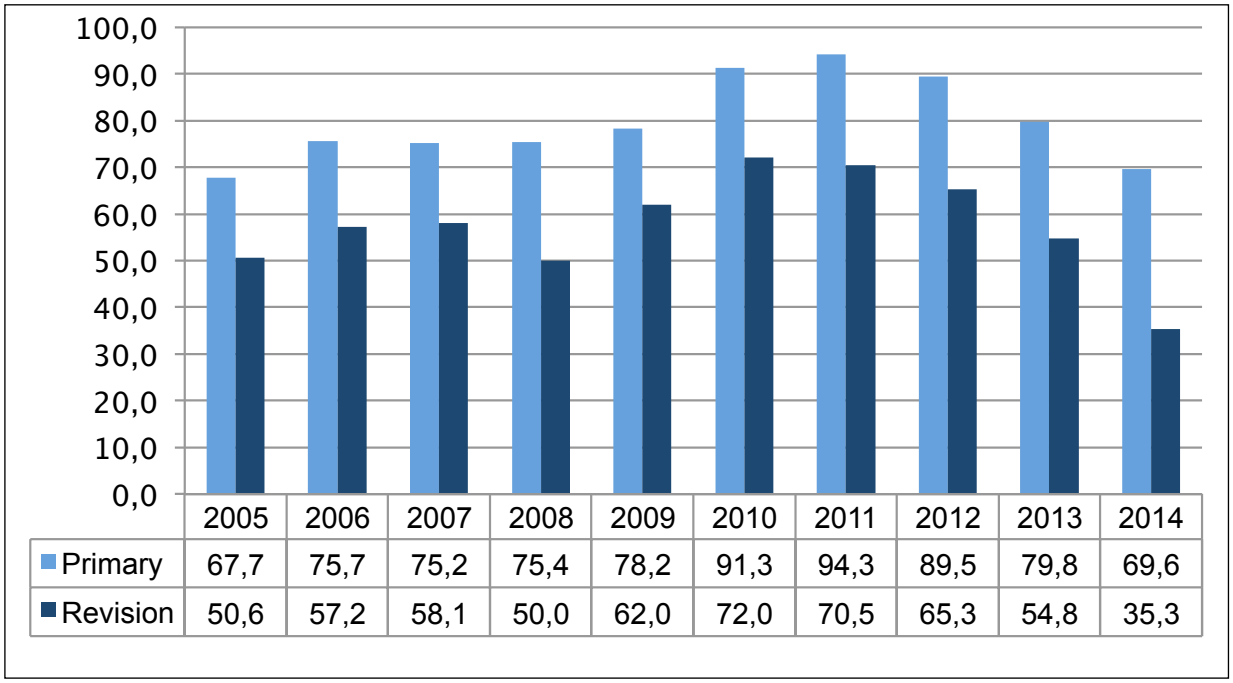
Table 4. ***Number of knee arthroplasties by health care region, centre, period and by type of arthroplasty. Source RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
Hospital	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	% revision
Lleida												
Hospital Universitari Arnau de Vilanova	0	0	0	2	108	12	161	4	255	2	**524**	**3.7**
Hospital de Santa Maria	164	9	307	20	324	21	284	18	330	4	**1,409**	**4.9**
Clínica de Ponent	52	6	208	9	172	15	195	5	213	2	**840**	**4.2**
Camp de Tarragona												
Hospital Universitari de Tarragona Joan XXIII	1	0	129	17	254	23	277	12	323	24	**984**	**7.2**
Hospital Universitari Sant Joan de Reus	2	0	92	0	313	0	241	1	127	0	**775**	**0.1**
Hospital de Sant Pau i Santa Tecla	36	0	203	6	220	13	211	10	237	12	**907**	**4.3**
Pius Hospital de Valls	87	3	156	3	120	4	112	2	132	10	**607**	**3.5**
Hospital del Vendrell	3	0	237	4	250	6	173	6	198	19	**861**	**3.9**
Terres de l´Ebre												
Hospital Tortosa Verge de la Cinta	0	0	0	0	309	59	200	36	227	48	**736**	**16.3**
Hospital Comarcal Móra d'Ebre	0	0	0	0	328	0	200	0	78	0	**606**	**0.0**
Girona												
Hospital Universitari de Girona Josep Trueta	0	0	243	34	173	53	243	47	389	12	**1,048**	**12.2**
Clínica Girona SA	0	0	0	0	200	11	167	4	122	0	**489**	**3.0**
Clínica Salus Infirmorum	0	0	0	0	0	0	0	0	39	3	**39**	**7.1**
Hospital Comarcal de Blanes	287	35	358	29	384	26	266	20	272	14	**1,567**	**7.3**
Hospital de Campdevanol	46	0	51	0	53	0	44	0	63	0	**257**	**0.0**
Hospital de Figueres	178	13	343	26	356	28	257	37	91	8	**1,225**	**8.4**
Hospital de Palamós	272	20	282	12	277	18	191	19	234	38	**1,256**	**7.9**
Hospital de Sant Jaume d'Olot	223	13	44	7	149	17	86	18	145	12	**647**	**9.4**
Hospital Provincial Santa Caterina	184	2	190	10	237	16	242	14	332	15	**1,185**	**4.6**
Catalunya Central												
Centre Hospitalari-ALTHAIA	372	37	778	62	674	127	610	134	598	103	**3,032**	**13.3**
Hospital General de Vic	154	1	123	4	224	7	288	33	372	32	**1,161**	**6.2**
Hospital de Sant Bernabé	0	0	51	4	122	8	103	8	150	5	**426**	**5.5**
Fundació Sanitaria d'Igualada FP	89	5	185	23	198	34	163	25	162	13	**797**	**11.2**

Hospital	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	% revision
Alt Pirineu i Aran												
Fundació Sant Hospital de la Seu d'Urgell	50	1	46	0	51	3	38	4	46	0	**231**	**3.4**
Hospital Comarcal del Pallars	22	0	29	0	64	0	64	0	65	0	**264**	**0.0**
Hospital de Puigcerdà	25	2	21	0	20	0	32	2	13	0	**111**	**3.5**
Barcelona												
Hospital de Viladecans	0	0	0	0	108	13	190	14	177	1	**475**	**5.6**
Hospital Universitari de Bellvitge	292	0	276	0	482	11	351	16	200	4	**1,601**	**1.9**
H.Universitari Germans Trias i Pujol	0	0	35	3	376	36	346	18	463	3	**1,220**	**4.7**
Hospital Clinic i Provincial de Barcelona	1,612	174	1,062	275	1,242	319	834	294	824	272	**5,574**	**19.3**
Hospital de L'Hospitalet - CSI	599	37	458	29	537	55	411	52	7	489	**2,012**	**24.8**
Hospital Dos de Maig de Barcelona - CSI	114	6	114	9	231	11	244	9	137	118	**840**	**15.4**
Hospital Mútua de Terrassa	0	0	389	44	581	52	493	68	158	23	**1,621**	**10.3**
Hospital de l'Esperit Sant	185	11	306	27	391	50	284	22	375	9	**1,541**	**7.2**
Corporació Sanitária Parc Taulí	231	32	639	84	630	82	542	63	326	96	**2,368**	**13.1**
Hospital de Sant Boi- Parc Sanitari St Joan de Deu	225	14	307	14	237	32	219	25	318	24	**1,306**	**7.7**
Hospital de Sant Celoni - Fundació privada	99	11	174	13	130	25	154	12	134	6	**691**	**8.8**
Hospital de Terrassa	0	0	257	28	287	27	239	17	371	16	**1,154**	**7.1**
Parc de Salut del Mar	139	27	414	26	506	88	750	125	0	0	**1,395**	**14.7**
Hospital General de Granollers	257	35	339	18	83	11	327	34	391	49	**1,472**	**9.5**
Hospital Municipal de Badalona	330	20	268	83	289	20	191	21	252	18	**1,401**	**6.5**
Hospital Residència Sant Camil	364	41	289	18	213	68	126	24	192	25	**1,163**	**17.2**
Hospital Sant Joan de Déu de Martorell	108	7	0	0	270	29	149	49	80	28	**896**	**12.8**
Hospital de Sant Joan de D`Esplugues Llob	0	0	0	0	1	0	0	0	1	0	**2**	**0.0**
Hospital Sant Rafael	0	0	0	0	378	54	302	57	368	49	**1,048**	**13.3**
F.G.S. Hospital de la Santa Creu i Sant Pau	0	0	0	0	226	29	394	50	427	54	**1,047**	**11.3**

Hospital	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	% revision
Barcelona *(cont.)*												
H. de Plató	0	0	133	7	150	10	58	2	77	3	**418**	**5.0**
Hospital Universitari Sagrat Cor	315	38	495	43	543	49	618	47	755	55	**2,726**	**7.8**
Fundació Privada Hospital de Mollet	135	7	146	11	152	4	220	6	289	1	**942**	**3.0**
Hospital Comarcal de l'Alt Penedes	0	0	166	13	165	29	136	12	186	22	**653**	**10.4**
Hospital de Mataro	116	16	412	28	448	30	275	17	280	26	**1,531**	**7.1**
H. Universitari Vall d'Hebron	455	0	812	0	583	55	464	25	797	26	**3,111**	**3.3**
Total	7,823	623	11,587	1,045	14,819	1,690	13,165	1,538	12,798	1,793	60,192	10.0

Figure 3. ***Completeness of data sent to the RACat per year, and by type of arthroplasty. Source RACat-MBD-SHD***



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Primary	67,7	75,7	75,2	75,4	78,2	91,3	94,3	89,5	79,8	69,6
Revision	50,6	57,2	58,1	50,0	62,0	72,0	70,5	65,3	54,8	35,3

Figure 4. ***Percentage of completeness of primary knee arthroplasties per centre during the period 2013-2014. Source: RACat***

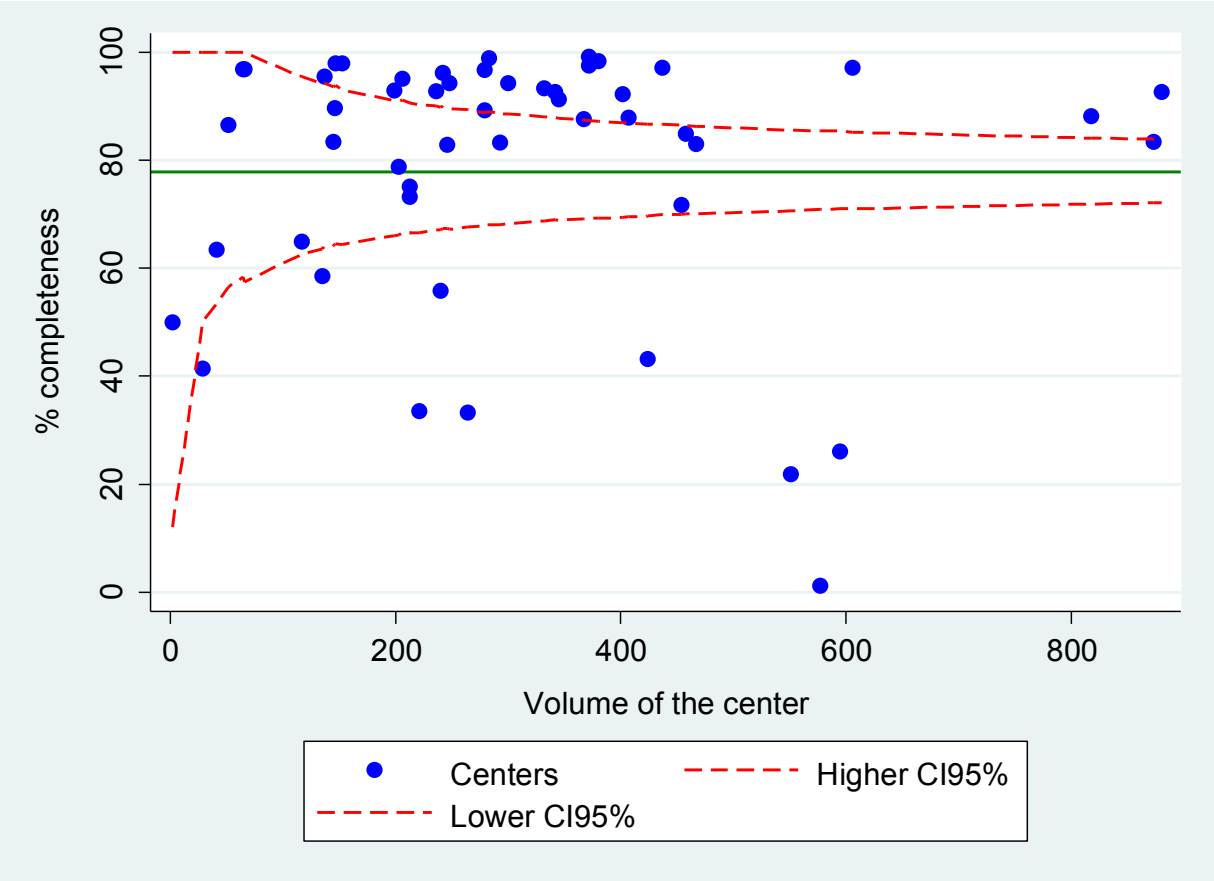


Table 5. ***Percentages of classified primary knee arthroplasties in relation to the volume sent to the RACat. Source: RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Classified	4,637	59.3	9,409	81.2	12,925	87.2	12,003	91.2	10,486	81.9	**49,460**	**82.2**
Not Classified	3,186	40.7	2,178	18.8	1,894	12.8	1,162	8.8	2,312	18.1	**10,732**	**17.8**
Total	**7,823**	**100.0**	**11,587**	**100.0**	**14,819**	**100.0**	**13,165**	**100.0**	**12,798**	**100.0**	**60,192**	**100.0**

Figure 5. ***Percentages of classified primary knee arthroplasties per centre in relation to the volume of data sent in the period 2013-2014. Source: RACat.***

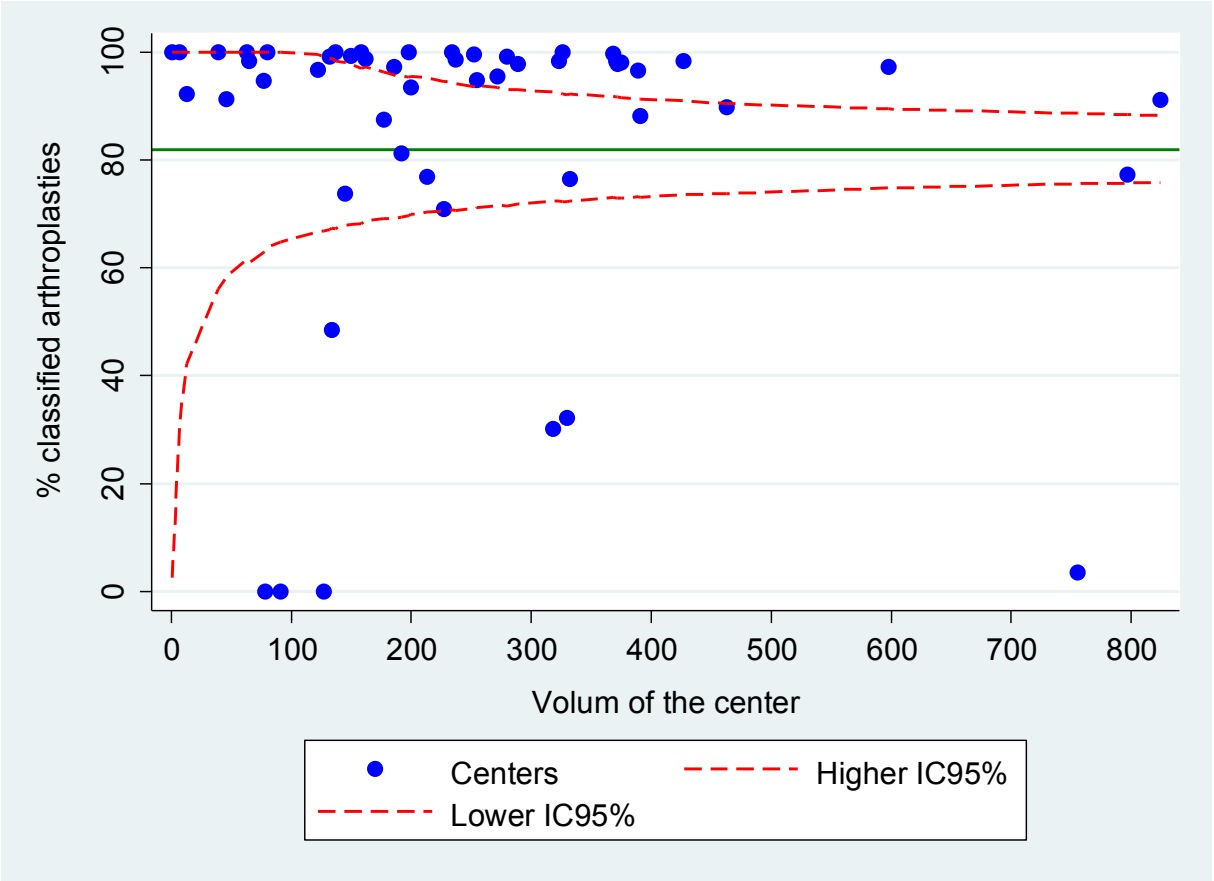
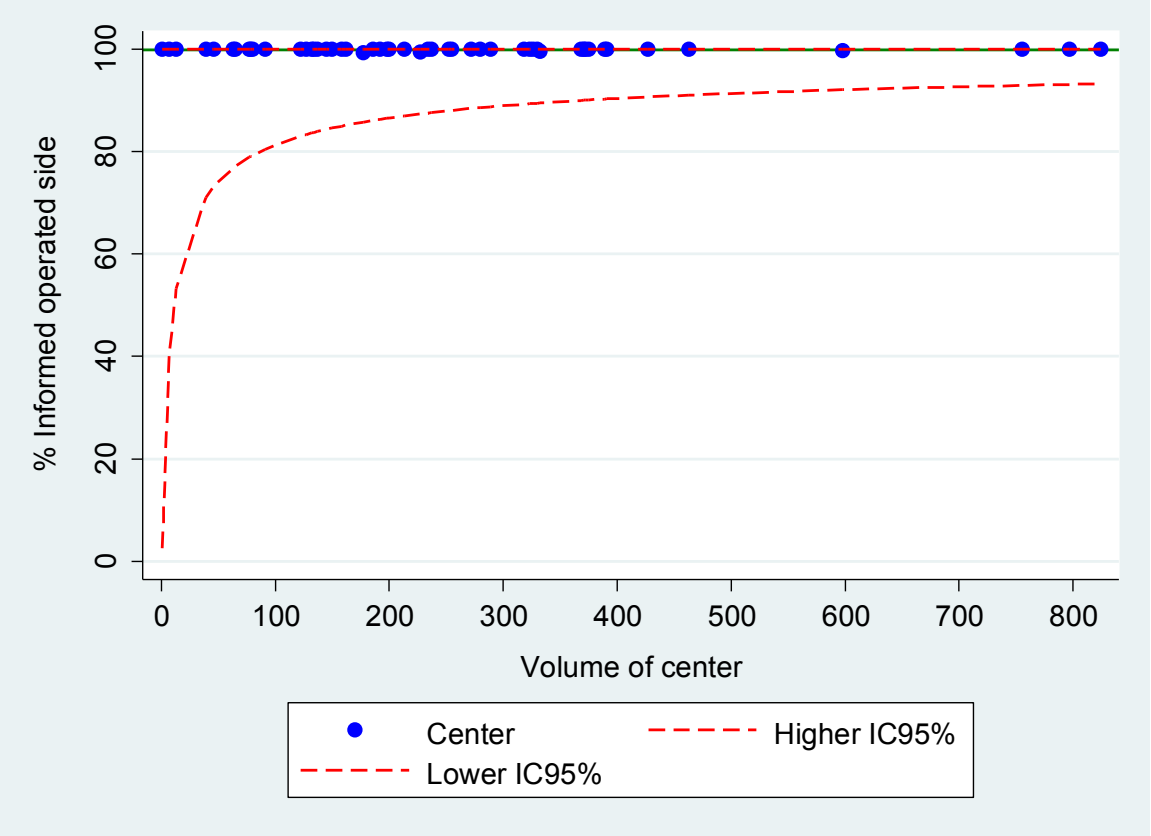


Table 6. ***Number of knee arthroplasties with the operated side (left or right) reported by period. Source RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Reported	6,030	71.4	11,892	94.1	16,144	97.8	14,581	99.2	14,574	99.9	**63,221**	**94.5**
Not reported	2,416	28.6	740	5.9	365	2.2	122	0.8	17	0.1	**3,660**	**5.5**
Total	**8,446**	**100.0**	**12,632**	**100.0**	**16,509**	**100.0**	**14,703**	**100.0**	**14,591**	**100.0**	**66,881**	**100.0**

Figure 6. ***Percentage of primary arthroplasties and knee replacements with reported laterality per centre in relation to volume of data sent in the latter period. Source RACat.***



4.2. Demographic and patient treatment process profile

From this section on, the results are presented split by total and partial knee arthroplasties.

The average age of patients undergoing a primary total knee arthroplasty was 72.2 years (standard deviation; SD: 7.6) and for those who underwent a partial knee arthroplasty was 65.5 years (SD: 9.7), being the percentage of women 71.4% and 67.0%, respectively (Table 7, Table 8).

In the time period spanning between 2005 and 2014, the age group distribution among patients with a total knee arthroplasty remained relatively stable (Figure 7). However, for those patients who experienced a partial knee arthroplasty the percentage of patients aged between 75 to 84 years increased over time.

Table 9 and Table 10 shows the demographic characteristics and treatment profile of patients who underwent total and partial knee arthroplasty, respectively. Patients undergoing a primary total knee arthroplasties were older that those undergoing a partial procedure, the mean age for the period 2013-2014 being 72.3 years and 66.8 years, respectively. The data shows that the main reason for intervention of arthroplasties carried out during the latter study period was osteoarthritis in 98.7% of primary total knee arthroplasties and 96.9% for partial knee arthroplasties. For the latter group, a gradual increase of this cause of intervention over time was observed. Mechanical complications were the main cause for revision both for total and partial knee arthroplasties. As expected by differences in patient's age distribution, the percentage of patients with 1 or more comorbidities was higher for patients undergoing total knee arthroplasties in comparison to those undergoing a partial knee arthroplasty.

Table 7. ***Age and sex of patients undergoing a primary total knee arthroplasty by health care regions and period. Source RACat.***

	2005/2006			2007/2008			2009/2010			2011/2012			2013/2014			Total		
	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women
Lleida	197	72.9 (6.2)	68.0	460	73.9 (6.5)	67.6	556	73.0 (6.8)	66.7	562	73.3 (7.1)	65.8	511	72.9 (7.5)	68.1	2,286	**73.3 (7.0)**	**67.1**
Camp de Tarragona	126	72.6 (6.0)	71.4	643	72.4 (6.9)	69.1	827	72.2 (6.8)	71.5	756	71.8 (7.2)	71.0	875	72.1 (7.2)	67.5	3,227	**72.2 (7.0)**	**69.8**
Terres de l'Ebre	0	0	0.0	0	0	0.0	301	71.4 (7.2)	57.8	180	71.3 (7.7)	61.1	161	71.6 (7.9)	57.8	642	**72.1 (7.6)**	**58.7**
Girona	926	72.2 (7.1)	69.2	1,081	71.8 (7.2)	68.2	1,314	72.1 (7.6)	67.0	1,183	71.9 (8.2)	67.3	1,445	72.0 (8.0)	65.5	5,949	**72.0 (7.7)**	**67.2**
Catalunya central	441	72.1 (7.4)	72.8	1,029	71.6 (7.8)	70.1	1,142	72.0 (7.5)	68.9	1,107	72.1 (7.6)	70.0	1,230	72.5 (7.5)	70.8	4,949	**72.1 (7.6)**	**70.2**
Alt pirineu i Aran	83	72.9 (8.0)	62.7	114	73.4 (7.5)	68.4	129	75.0 (7.7)	64.3	128	73.6 (6.3)	61.7	117	73.4 (7.0)	65.0	571	**73.7 (7.3)**	**64.5**
Barcelona	2,759	72.1 (7.3)	74.2	5,855	72.2 (7.5)	74.3	8,266	72.2 (7.7)	73.5	7,738	72.3 (7.7)	72.7	5,710	72.4 (7.8)	72.0	30,328	**73.2 (7.7)**	**73.2**
Total	**4,532**	**72.2 (7.2)**	**72.5**	**9,182**	**72.2 (7.4)**	**72.3**	**12,535**	**72.2 (7.6)**	**71.5**	**11,654**	**72.3 (7.7)**	**71.1**	**10,049**	**72.3 (7.7)**	**70.0**	**47,952**	**72.2 (7.6)**	**71.4**

Table 8. ***Age and sex of patients undergoing a primary partial knee arthroplasty by health care region and period. Source RACat.***

	2005/2006			2007/2008			2009/2010			2011/2012			2013/2014			Total		
	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women
Lleida	0	0	0	0	0	0	0	0	0	0	0	0	1	53.4	0	1	**53.4**	**0**
Camp de Tarragona	1	56.5	100.0	11	62.5 (7.4)	81.8	8	66.4 (7.7)	62.5	8	64.9 (8.0)	62.5	6	60.4 (2.1)	33.3	34	**63.4 (7.1)**	**64.7**
Terres de l'Ebre	0	0	0.0	0	0	0.0	5	62.1 (4.6)	60.0	1	61.2	100.0	0	0	0.0	6	**61.9 (4.1)**	**66.7**
Girona	6	62.1 (8.1)	83.3	15	65.1 (8.3)	66.7	17	65.5 (7.9)	64.7	8	58.5 (8.7)	75.0	6	59.1 (4.1)	66.7	52	**63.7 (8.4)**	**69.2**
Catalunya central	5	53.8 (8.6)	60.0	24	59.2 (9.0)	79.2	37	57.6 (9.4)	73.0	31	58.6 (8.8)	58.1	25	59.5 (10.5)	64.0	122	**58.3 (9.3)**	**68.0**
Alt pirineu i Aran	6	72.4 (8.1)	50.0	2	50.4 (1.1)	50.0	6	63.9 (10.4)	66.7	6	64.3 (11.0)	83.3	1	65.3	100.0	21	**64.8 (10.3)**	**66.7**
Barcelona	86	65.6 (8.3)	67.4	171	65.2 (9.6)	64.3	309	65.8 (9.4)	68.0	287	66.5 (10.1)	73.2	386	67.6 (9.2)	62.4	1,239	**66.4 (9.5)**	**66.9**
Total	**104**	**65.2 (8.8)**	**67.3**	**223**	**64.3 (9.5)**	**66.8**	**382**	**65.0 (9.6)**	**68.1**	**341**	**65.5 (10.0)**	**71.9**	**425**	**66.8 (9.5)**	**62.1**	**1,475**	**65.6 (9.7)**	**67.0**

Figure 7. ***Age of patients undergoing a primary knee arthroplasty by period. A) Total arthroplasties. B) Partial arthroplasties. Source RACat.***

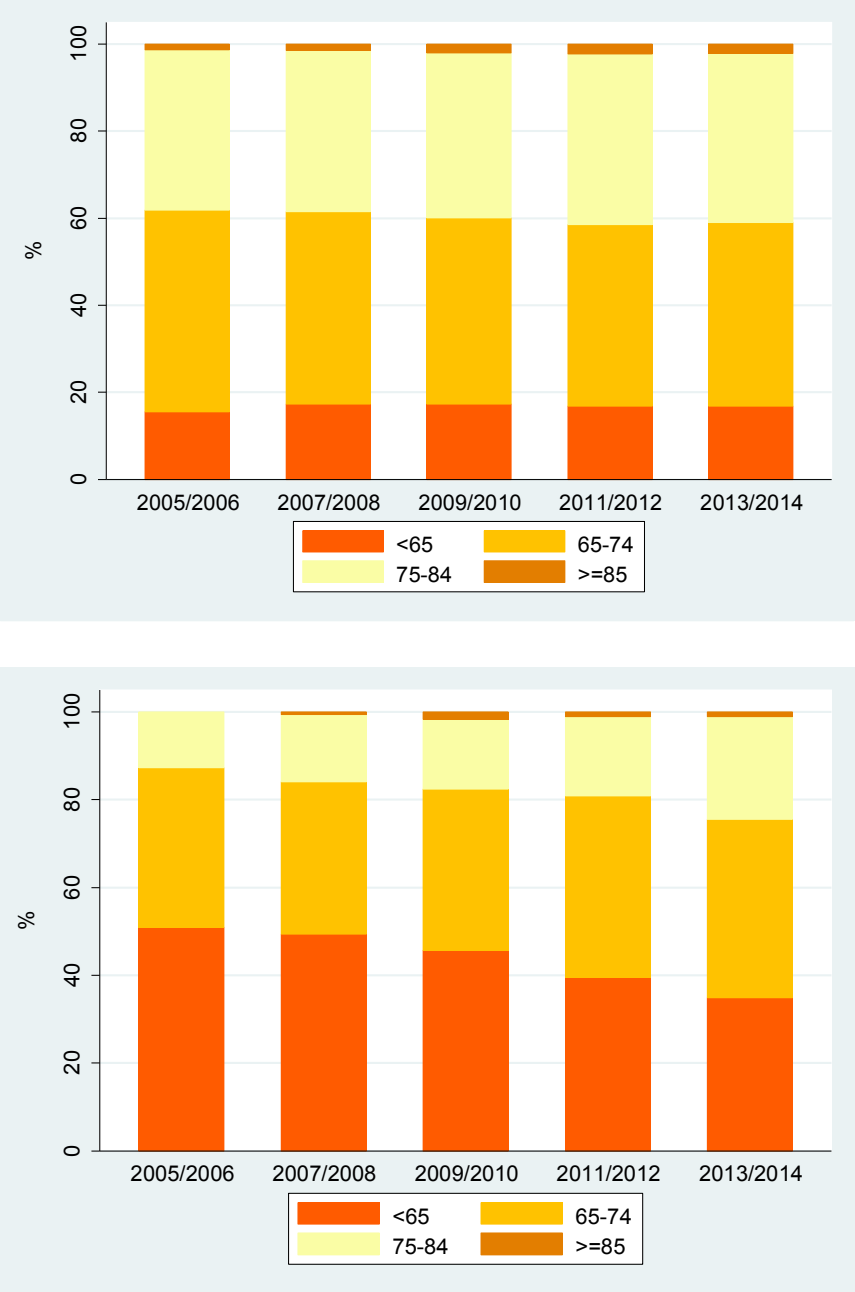


Table 9. ***Demographic and patient treatment profile of patients with primary and revision total knee arthroplasty by period. Source RACat-MBDSHD.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n	n
Number	4217	183	8,856	452	12,107	796	11,432	686	9,769	484
% of Women	3,068 (72.8)	120 (65.6)	6,417 (72.5)	322 (71.2)	8,663 (71.6)	601 (75.5)	8,133 (71.1)	506 (73.8)	6,831 (69.9)	371 (76.7)
Mean age (SD)	72.1 (7.1)	73.1 (7.7)	72.2 (7.4)	72.6 (8.2)	72.2 (7.6)	73.0 (8.1)	72.2 (7.7)	73.3 (8.9)	72.3 (7.7)	73.0 (8.9)
Cause of intervention										
Osteoarthritis	4,111 (97.5)		8,681 (98.0)		11,905 (98.3)		11,264 (98.5)		9,646 (98.7)	
Other diagnostics	106 (2.5)		175 (2.1)		202 (1.6)		168 (1.5)		123 (1.3)	
Cause of revision										
Mechanical complications		119 (65.0)		253 (56.0)		518 (65.1)		485 (70.7)		357 (73.8)
Infection		26 (14.2)		34 (7.5)		81 (10.2)		53 (7.7)		20 (4.13)
Other diagnostics		38 (20.8)		165 (36.5)		197 (24.8)		148 (21.6)		107 (22.1)
Comorbidity										
1 or more	2,459 (58.3)	99 (54.1)	5,667 (64.0)	281 (62.1)	8,206 (67.8)	547 (68.7)	8,224 (71.9)	496 (72.3)	7,229 (74.0)	372 (76.8)
Healthcare discharge	229 (5.43)	8 (4.4)	582 (6.6)	39 (8.6)	903 (7.5)	59 (7.4)	1185 (10.4)	69 (10.1)	870 (8.9)	48 (9.9)

Table 10. ***Demographic and patient treatment profile of patients with primary and revision partial knee arthroplasty by period. Source RACat-MBDSHD***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Number	94	0	219	0	371	3	336	2	424	0
% of Women	63 (67.0)	0	145 (66.2)	0	252 (67.9)	1 (33.3)	243 (72.3)	2 (100)	264 (62.3)	0
Mean age (SD)	65.2 (8.9)	0	64.4 (9.5)	0	65.0 (9.6)	68.4 (2.0)	65.7 (10.2)	65.7 (0.6)	66.8 (9.5)	0
Cause of intervention										
Osteoarthritis	73 (77.7)		185 (84.5)		325 (87.6)		308 (91.7)		411 (96.9)	
Other bone and cartilage diseases	14 (14.9)		18 (8.2)		21 (5.7)		18 (5.4)		5 (1.2)	
Other diagnostics	7 (7.5)		16 (7.3)		25 (6.7)		10 (3.0)		8 (1.9)	
Cause of revision										
Mechanical complications		0		0		2 (66.7)		1 (50.0)		0
Other diagnostics		0		0		1 (33.3)		1 (50.0)		0
Comorbidity										
1 or more	34 (36.2)	0	111 (50.7)	0	216 (58.2)	2 (66.7)	214 (63.7)	1 (50.0)	261 (61.6)	0
Healthcare discharge	0	0	0	0	1 (0.3)	0	11 (3.3)	0	7 (1.7)	0

Revision information refers to the partial prosthesis used in a revision procedure. In general, partial arthroplasties are exchanged by a total knee prosthesis.

4.3. Characteristics of primary arthroplasties

An overall of 49,427 knee arthroplasties could be classified for the whole study period. Total knee arthroplasties represented 97.0%, whereas partial knee arthroplasties represented 3.0%. Within total knee arthroplasties, the most common arthroplasties were those which preserve the posterior cruciate retaining (CR) and the posterior stabilized ones (PS), representing 46.0% and 51.7%, respectively (Table 11). Among partial knee arthroplasties, unicompartmental arthroplasties were the most common group followed by patellofemoral arthroplasties, representing the 82.9% and 16.3% of partial procedures, respectively.

The most frequent primary knee arthroplasties across age groups were also CR and PS (Figure 8). Unicompatmental prosthesis was the most common type among partial procedures, especially among older patients.

The most common fixation was cemented fixation both for total and partial knee arthroplasties (Table 12, Table 13 and Figure 9). Again, in total and partial knee arthroplasties the most common fixation technique in men and women (Table 14, Table 15) and across age groups (Table 16 and Table 17) was cemented fixation.

In relation to the type of arthroplasty, the cemented fixation technique was the most used overall. CR and PS were cemented in 63.8% and 87.7% of cases, respectively (Table 18). For partial knee arthroplasties, cemented fixation was the most common fixation type both for unicompartmental and patellofemoral prosthesis (Table 19).

Figure 8. ***Percentage distribution of primary knee arthroplasties by age group. A) Total arthroplasties; B) Partial arthroplasties. Source RACat.***

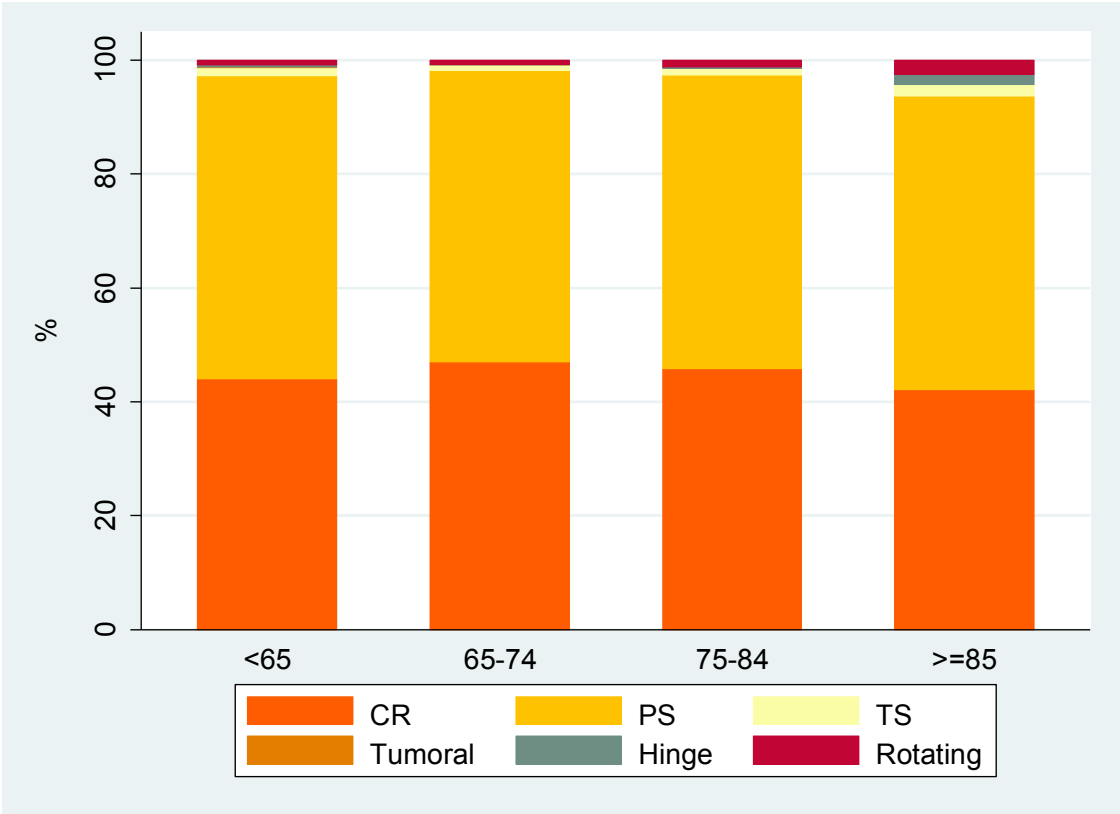


Table 11. ***Number of primary knee arthroplasties per type of arthroplasty and period.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Total knee arthroplasties												
Posterior cruciate retaining (CR)	2,060	45.5	3,875	42.2	5,649	45.1	5,604	48.1	4,856	48.3	**22,044**	**46,0**
Posterior stabilized (PS)	2,403	53.0	5,061	55.1	6,579	52.5	5,842	50.1	4,892	48.7	**24,777**	**51,7**
Constrained	42	0.9	104	1.1	132	1.1	93	0.8	156	1.6	**527**	**1,1**
Tumoral	0	0.0	2	0.0	1	0.0	5	0.0	8	0.1	**16**	**0,0**
Hinge	3	0.1	24	0.3	44	0.4	25	0.2	40	0.4	**136**	**0,3**
Rotational	24	0.5	116	1.3	130	1.0	85	0.7	97	1.0	**452**	**0,9**
Partial knee arthroplasties												
Patellofemoral	2	1.9	46	20.6	78	20.7	73	21.4	41	9.7	**240**	**16,3**
Unicompartmental	102	98.1	176	78.9	293	77.7	268	78.6	384	90.4	**1223**	**82,9**
Bicompartmental	0	0.0	1	0.5	6	1.6	0	0.0	0	0.0	**7**	**0,5**
Other types	1	100.0	4	100.0	13	100.0	8	100.0	12	100.0	**33**	**100.0**
Not specified	3,186	100.0	2,178	100.0	1,894	100.0	1,162	100.0	2,312	100.0	**10,732**	**100.0**
Total	**7,823**	**100.0**	**11,587**	**100.0**	**14,819**	**100.0**	**13,165**	**100.0**	**12,798**	**100.0**	**60,192**	**100.0**

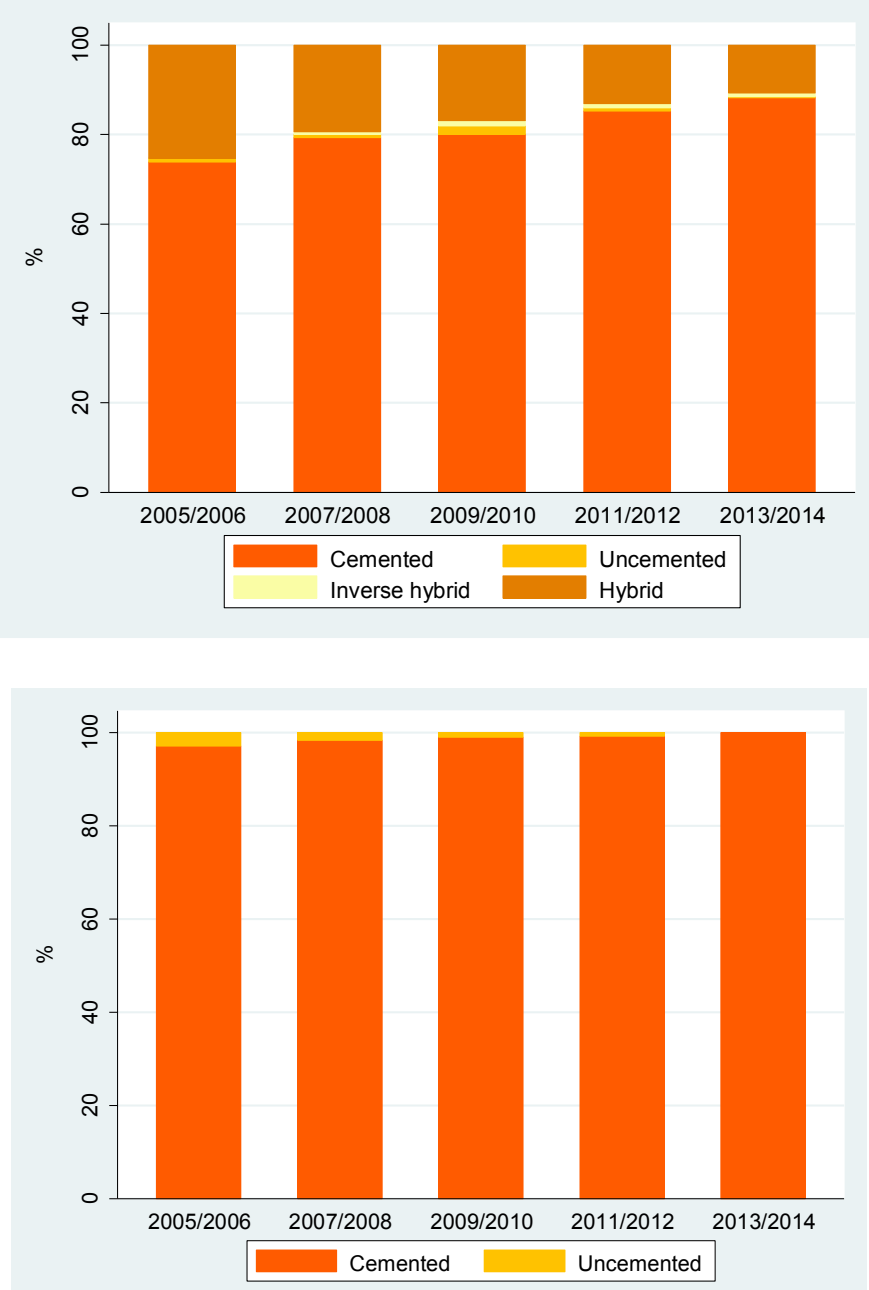
Table 12. ***Number of primary total knee arthroplasties per fixation technique by time period. Source: RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Cemented	3,235	71.4	6,841	74.5	9,314	74.3	8,999	77.2	7,901	78.6	**36,290**	**75.7**
Cementless	36	0.8	66	0.7	230	1.8	85	0.7	23	0.2	**440**	**0.9**
Hybrid	1,111	24.5	1,667	18.2	1,967	15.7	1,378	11.8	960	9.6	**7,083**	**14.8**
Inverse hybrid	0	0.0	50	0.5	131	1.1	99	0.9	72	0.7	**352**	**0.7**
Not specified	150	3.3	558	6.1	893	7.1	1,093	9.4	1,093	10.9	**3,787**	**7.9**
Total	**4,532**	**100.0**	**9,182**	**100.0**	**12,535**	**100.0**	**11,654**	**100.0**	**10,049**	**100.0**	**47,952**	**100.0**

Table 13. ***Number of primary partial knee arthroplasties per fixation technique by time period. Source: RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Cemented	99	95.2	173	77.6	299	78.3	264	77.5	372	87.5	**1,202**	**81.5**
Cementless	3	2.9	3	1.4	3	0.8	2	0.6	0	0.0	**11**	**0.8**
Not specified	2	1.9	47	21.1	80	20.9	75	22.0	53	12.5	**257**	**17.4**
Total	**104**	**100.0**	**223**	**100.0**	**382**	**100.0**	**341**	**100.0**	**425**	**100.0**	**1,475**	**100.0**

Figure 9. ***Percentage distribution of the fixation technique in primary knee arthroplasties by time period. A) Total knee arthroplasties; B) Partial knee arthroplasties. Source: RACat***



Prosthesis with not specified fixation technique were not plotted.

Table 14. *Number of primary total knee arthroplasties per fixation technique by sex. Source RACat.*

	Men		Women		Total	
	n	%	n	%	n	%
Cemented	9,998	72.8	26,292	76.8	**36,290**	**75.7**
Cementless	152	1.1	288	0.8	**440**	**0.9**
Hybrid	2,018	14.7	5,065	14.8	**7,083**	**14.8**
Inverse hybrid	68	0.5	284	0.8	**352**	**0.7**
Not specified	1,497	10.9	2,290	6.7	**3,787**	**7.9**
Total	**13,733**	**100.0**	**34,219**	**100.0**	**47,952**	**100.0**

Table 15. *Number of primary partial knee arthroplasties per fixation technique by sex. Source RACat*

	Men		Women		Total	
	n	%	n	%	n	%
Cemented	412	84.6	795	80.5	**1,207**	**81.8**
Cementless	6	1.2	5	0.5	**11**	**0.8**
Not specified	69	14.2	188	19.0	**257**	**17.4**
Total	**487**	**100.0**	**988**	**100.0**	**1,475**	**100.0**

Table 16. *Number of primary total knee arthroplasties per fixation technique by age group. Source RACat.*

	<65		65-74		75-84		>=85		Total	
	n	%	n	%	n	%	n	%	n	%
Cemented	5,848	71.6	15,371	74.7	14,298	78.3	773	80.8	**36,290**	**75.7**
Cementless	145	1.8	185	0.9	103	0.6	7	0.7	**440**	**0.9**
Hybrid	1,374	16.8	3,286	16.0	2,340	12.8	83	8.7	**7,083**	**14.8**
Inverse hybrid	107	1.3	170	0.8	75	0.4	0	0.0	**352**	**0.7**
Not specified	692	8.5	1,560	7.6	1,441	7.9	94	9.8	**3,787**	**7.9**
Total	**8,166**	**100.0**	**20,572**	**100.0**	**18,257**	**100.0**	**957**	**100.0**	**47,952**	**100.0**

Table 17. ***Number of primary partial knee arthroplasties per fixation technique by age group. Source RACat.***

	<65		65-74		75-84		>=85		Total	
	n	%	n	%	n	%	n	%	n	%
Cemented	505	75.0	469	86.9	220	89.1	13	92.9	**1,207**	**81.8**
Cementless	7	1.0	1	0.2	3	1.2	0	0.0	**11**	**0.8**
Not specified	162	24.0	70	13.0	24	9.7	1	7.1	**257**	**17.4**
Total	**674**	**100.0**	**540**	**100.0**	**247**	**100.0**	**14**	**100.0**	**1,475**	**100.0**

Table 18. ***Number of primary total knee arthroplasties by fixation technique. Source RACat***

	CR		PS		Constrained		Tumoral		Hinge		Rotational		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Cemented	14,067	63.8	21,737	88	424	80.5	0	0.0	58	42.7	4	0.9	**36,290**	**75.7**
Cementless	292	1.3	148	1	0	0.0	0	0.0	0	0.0	0	0.0	**440**	**0.9**
Inverse hybrid	190	0.9	162	1	0	0.0	0	0.0	0	0.0	0	0.0	**352**	**0.7**
Hybrid	5,384	24.4	1,665	7	32	6.1	2	12.5	0	0.0	0	0.0	**7,083**	**14.8**
Not specified	2,111	9.6	1,065	4	71	13.5	14	87.5	78	57.4	448	99.1	**3,787**	**7.9**
Total	**22,044**	**100.0**	**24,777**	**100**	**527**	**100.0**	**16**	**100.0**	**136**	**100.0**	**452**	**100.0**	**47,952**	**100.0**

CR: Posterior cruciate retaining; PS: Posterior stabilized

Table 19. ***Number of primary partial knee arthroplasties by fixation technique. Source: RACat***

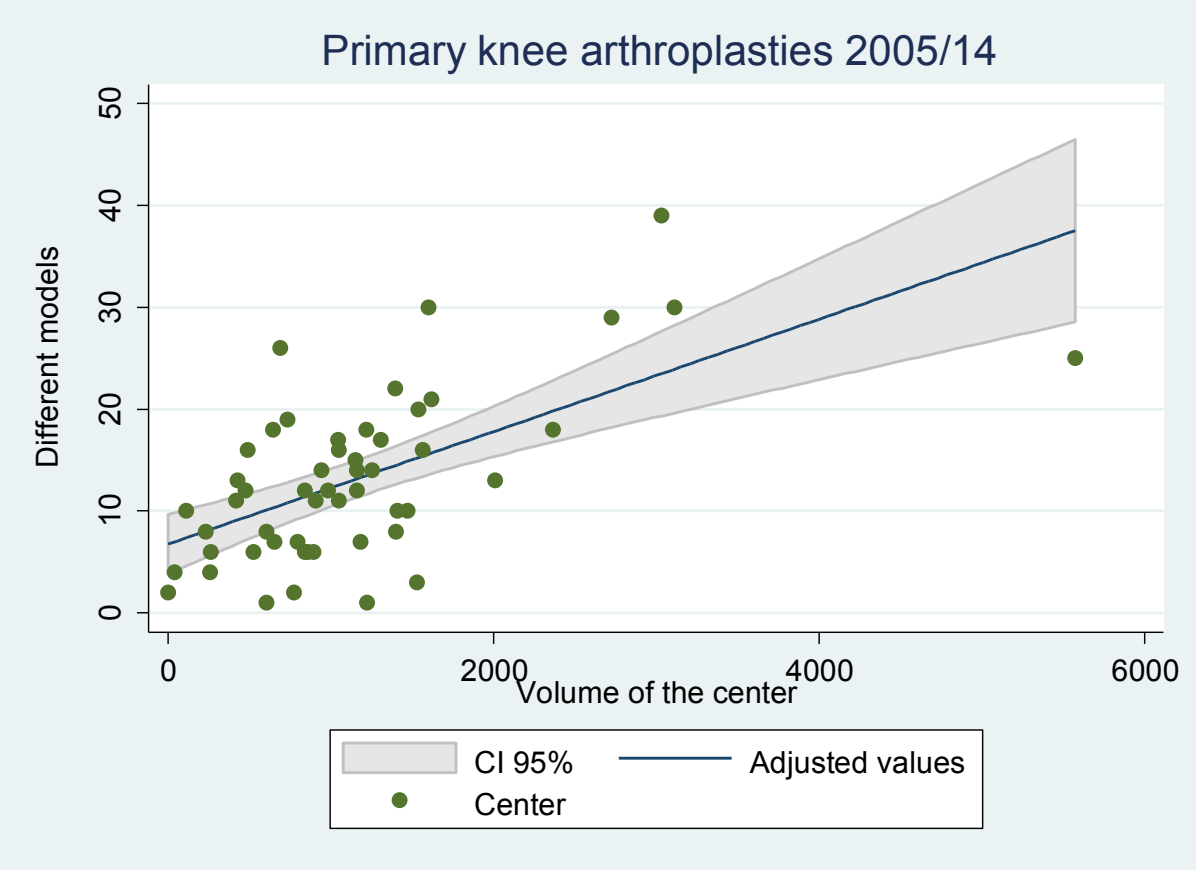
	Patellofemoral		Bicompartmental		Unicompartmental		Total	
	n	%	n	%	n	%	n	%
Cemented	15	93.8	7	100	1,185	96.9	**1,207**	**81.8**
Cementless	0	0.0	0	0	11	0.9	**11**	**0.8**
Not specified	225	93.8	0	0	27	2.2	**252**	**17.4**
Total	**240**	**100.0**	**7**	**100**	**1,223**	**100.0**	**1,470**	**100.0**

4.4. Characteristics of implant models

In the period 2005-2014, from all the prosthesis correctly classified, a total of 137 models (counting the cemented and cementless models separately) were identified. Figure 10 shows the variability in the usage of different prosthesis models in the hospitals participating in the RACat. As a general trend, there is a tendency towards use of a wider range of models as the number of arthroplasties performed in the hospital rises. In primary knee arthroplasties, the number of models used per hospital ranged from 1 to 38, with an average of 12.

The five most frequent implant models by type of fixation and by type of knee arthroplasty are described in Table 20 and Table 21, respectively. NEXGEN was the most common cemented implant across the study period. Models for cementless and inverse hybrid prosthesis showed some variation over the study periods, GEMINI LINK being the most used model in both groups during the period 2013-2014. For hybrid prosthesis, ADVANCE model was used mainly during the period 2005-2012, but SIGMA increased during the latter period.

Figure 10. ***Number of different prosthesis models in relation to the volume of primary knee arthroplasties in the 2005-2014 period. Source RACat.***



Both total and partial arthroplasties were considered.

Table 20. ***Five most frequent models in primary knee arthroplasty per fixation type and period. Source RACat.***

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
Cemented														
NEXGEN cim	743	22.3	NEXGEN cim	1,735	24.7	NEXGEN cim	1,642	17.1	NEXGEN cim	1,680	18.1	NEXGEN cim	1,692	20.5
PROFIX cim	386	11.6	SIGMA cim	809	11.5	PROFIX cim	1,348	14.0	PROFIX cim	1,113	12.0	GENUTECH cim	1,170	14.1
SCORPIO cim	334	10.0	PROFIX cim	689	9.8	GENUTECH cim	1,015	10.6	GENUTECH cim	999	10.8	SIGMA cim	1,154	14.0
ADVANCE cim	312	9.4	SCORPIO cim	571	8.1	SCORPIO NRG cim	884	9.2	SIGMA cim	740	8.0	TRIATHLON cim	891	10.8
OPTETRAK cim	266	8.0	GENUTECH cim	416	5.9	SIGMA cim	833	8.7	TRIATHLON cim	921	10.0	LEGION cim	549	6.6
Cementless														
TRI CCC	17	43.6	TRI CCC	22	31.9	ALPINA	97	41.6	TRI CCC	25	28.7	GEMINI LINK	11	47.8
SKS	11	28.2	SKS	21	30.4	VANGUARD	45	19.3	VANGUARD ROCC	16	18.4	INNEX	3	13.0
EMOTION	6	15.4	EMOTION	17	24.6	TRI CCC	30	12.9	GEMINI LINK	13	14.9	PROFIX	1	4.4
UKS	3	7.7	NEXGEN	4	5.8	SKS	22	9.4	SKS	10	11.5	TRI CCC	1	4.4
PROFIX	2	5.1	UKS	3	4.4	GENESIS II	13	5.6	ALPINA	8	9.2	VANGUARD ROCC	7	30.4
Hybrid														
ADVANCE	696	62.6	ADVANCE	601	36.0	ADVANCE	688	34.9	ADVANCE	521	37.8	SIGMA	311	32.4
913	139	12.5	AGC	455	27.3	AGC	546	27.7	GENUTECH	332	24.1	GENUTECH	298	31.0
GENUTECH	89	8.0	GENUTECH	194	11.6	SIGMA	265	13.5	SIGMA	214	15.5	ADVANCE	172	17.9
SIGMA	77	6.9	SIGMA	106	6.4	GENUTECH	100	5.1	AGC	68	4.9	UKNEE	82	8.5
UKNEE	30	2.7	913	77	4.6	VANGUARD	72	3.7	UKNEE	61	4.4	VANGUARD	26	2.7
Inverse hybrid														
			GEMINI LINK cim	35	70.0	GEMINI LINK cim	54	40.9	NEXGEN cim	38	36.9	GEMINI LINK cim	21	29.2
			NEXGEN cim	10	20.0	NEXGEN cim	50	37.9	VANGUARD cim	33	32.0	NEXGEN LPS FLEX cim	1	1.4
			EMOTION cim	1	2.0	VANGUARD cim	18	13.6	GEMINI LINK cim	25	24.3	NEXGEN cim	35	48.6
			PROFIX cim	1	2.0	ALPINA cim	3	2.3	HLS UNI EVOLUTION cim	3	2.9	VANGUARD cim	15	20.8
			SCORPIO cim	1	2.0	NEXGEN LPS FLEX cim	3	2.3	PROFIX cim	1	1.0		0	0.0

Table 21. ***Five most frequent models in primary knee arthroplasty per type of arthroplasty and period. Source RACat.***

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
CR														
ADVANCE	400	19.4	PROFIX cim	710	18.3	PROFIX cim	1,313	23.2	PROFIX cim	1,090	19.5	SIGMA cim	977	20.1
PROFIX cim	385	18.7	SIGMA cim	619	16.0	SIGMA cim	610	10.8	VANGUARD cim	705	12.6	VANGUARD cim	692	14.3
SIGMA cim	170	8.3	ADVANCE	389	10.0	ADVANCE	425	7.5	SIGMA cim	558	10.0	GENUTECH cim	523	10.8
913	139	6.8	AGC	268	6.9	GENUTECH cim	338	6.0	GENUTECH cim	382	6.8	TRIATHLON cim	339	7.0
SCORPIO cim	129	6.3	GENUTECH	195	5.0	AGC	280	5.0	GENUTECH	326	5.8	SIGMA	317	6.5
PS														
NEXGEN cim	665	27.7	NEXGEN cim	1,616	31.9	NEXGEN cim	1,556	23.7	NEXGEN cim	1,675	28.7	NEXGEN cim	1,688	34.5
ADVANCE	295	12.3	SCORPIO cim	485	9.6	SCORPIO NRG cim	942	14.3	TRIATHLON cim	662	11.3	GENUTECH cim	588	12.0
SCORPIO cim	208	8.7	GENUTECH cim	384	7.6	GENUTECH cim	715	10.9	GENUTECH cim	601	10.3	TRIATHLON cim	559	11.4
OPTETRAK cim	184	7.7	SCORPIO NRG cim	270	5.3	TRIATHLON cim	467	7.1	GENESIS II cim	393	6.7	LEGION cim	397	8.1
ALPINA cim	181	7.5	SIGMA cim	233	4.6	GENESIS II cim	333	5.1	NEXGEN GSF cim	357	6.1	VANGUARD cim	319	6.5
Constrained														
PERFORMANCE cim	15	35.7	NEXGEN cim	45	43.3	NEXGEN cim	29	22.0	NEXGEN cim	27	29.0	GENUTECH cim	66	42.3
NEXGEN cim	8	19.1	PERFORMANCE cim	21	20.2	GENUTECH cim	27	20.5	GENUTECH cim	21	22.6	TRIATHLON cim	27	17.3
SCORPIO cim	7	16.7	SCORPIO cim	13	12.5	SCORPIO cim	20	15.2	GENESIS II cim	8	8.6	NEXGEN cim	23	14.7
ADVANCE cim	5	11.9	913 cim	10	9.6	PERFORMANCE cim	16	12.1	TRIATHLON cim	7	7.5	GENUTECH	18	11.5
SIGMA TC3 cim	4	9.5	GENUTECH cim	7	6.7	LEGION cim	12	9.1	PERFORMANCE cim	6	6.5	LEGION cim	11	7.1
Tumoral			PSO	2	100.0	STANMORE cim	1	100.0	METS	5	100.0	METS	7	100.0
Hinge														
ENDO-MODEL LINK cim	1	33.3	ROTAX cim	11	45.8	ENDO-MODEL-M	11	25.0	ENDO-MODEL-M	9	36.0	ENDO-MODEL-M	15	37.5

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
NOILES cim	1	33.3	ENDO-MODEL-M	5	20.8	NEXGEN cim	8	18.2	MRH cim	3	12.0	NEXGEN cim	9	22.5
ROTAX cim	1	33.3	GMRS cim	2	8.3	RHK cim	8	18.2	OSS cim	3	12.0	MEGASYS-TEM-C LINK cim	8	20.0
			NOILES cim	2	8.3	ROTAX cim	7	15.9	MEGASYSTEM-C LINK cim	2	8.0	OSS cim	3	7.5
			NEXGEN cim	1	4.2	MRH cim	4	9.1	METS cim	2	8.0	NOILES cim	2	5.0
Rotational														
ENDO-MODEL LINK cim	24	100.0	ENDO-MODEL LINK cim	116	100.0	ENDO-MODEL LINK cim	128	98.5	ENDO-MODEL LINK cim	83	97.7	ENDO-MODEL LINK cim	97	100.0
						RHK cim	2	1.5	PROFIX cim	1	1.2			
									RHK cim	1	1.2			
Patellofemoral														
MIS AVON cim	1	50.0	ACCURIS cim	2	4.4	COMPETITOR cim	36	46.2	COMPETITOR cim	47	64.4	COMPETITOR cim	24	58.5
SPHEROCEN-TRIC cim	1	50.0	COMPETITOR cim	34	73.9	FPV cim	13	16.7	PFJ cim	9	12.3	VANGUARD PFC cim	6	14.6
Inverse hybrid			MIS AVON cim	5	10.9	ACCURIS cim	8	10.3	FPV cim	6	8.2	FPV cim	5	12.2
			SPHEROCENTRIC cim	4	8.7	PFJ cim	5	6.4	ACCURIS cim	5	6.9	PFJ cim	2	4.9
			VANGUARD PFC cim	1	2.2				SPHEROCENTRIC cim	2	2.7			
Bicompartmental														
			JOURNEY DEUCE cim	1	100.0	JOURNEY DEUCE cim	6	100.0						
Unicompartmental														
ZIMMER UNI KNEE cim	26	25.5	ZIMMER UNI KNEE cim	54	30.7	ACCURIS cim	110	37.5	ACCURIS cim	156	58.2	ACCURIS cim	253	65.9
ACCURIS cim	25	24.5	ACCURIS cim	50	28.4	OXFORD III cim	76	25.9	OXFORD III cim	54	20.2	SIGMA cim	64	16.7

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
OXFORD III cim	16	15.7	OXFORD III cim	42	23.9	ZIMMER UNI KNEE cim	54	18.4	TRIATHLON cim	21	7.8	OXFORD III cim	51	13.3
MILLER/GAL-LAN- TE cim	13	12.8	ENDO-MODEL LINK cim	14	8.0	ENDO-MODEL LINK cim	15	5.1	SIGMA cim	11	4.1	TRIATHLON cim	6	1.6
ADVANCE cim	10	9.8	EIUS cim	7	4.0	COMPETITOR cim	13	4.4	ZIMMER UNI KNEE cim	9	3.4	OXFORD cim	4	1.0

Percentages were calculated for each model out of total prosthesis used in each type of arthroplasty. Only the values of the 5 most common models are shown in the table, which explains that for some types of arthroplasties percentages do not add up to 100.

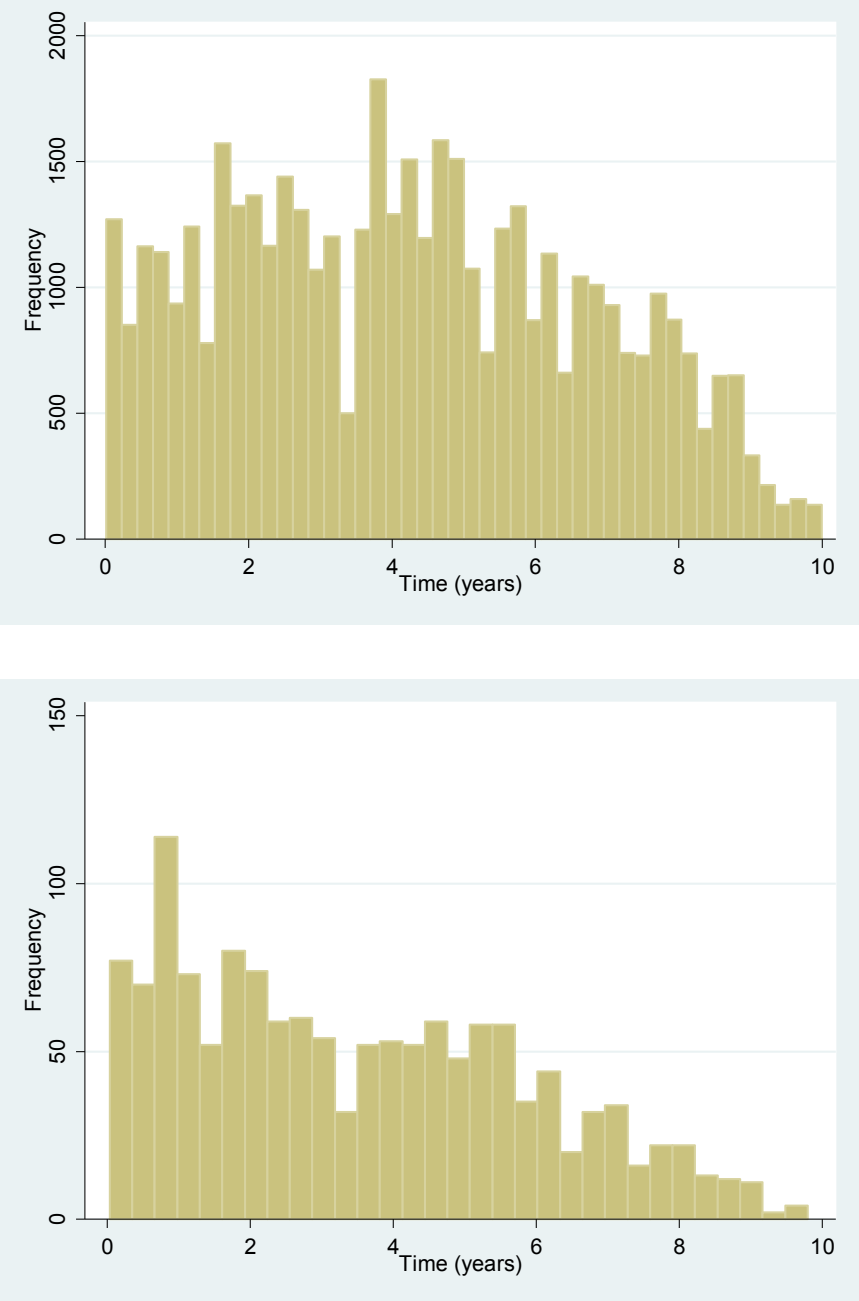
CR: Posterior cruciate retaining; PS: Posterior stabilized

4.5. Implant survival in knee arthroplasties

Follow-up description

The median length of follow-up from the date of primary arthroplasty until the revision surgery or censorship was 4.22 years (SD: 2.48) and 3.48 years (SD: 2.37) for total and partial arthroplasties, respectively. Figure 11 shows the distribution of follow-up time for patients undergoing total and partial knee arthroplasty.

Figure 11. ***Distribution of the follow-up time of the patients with primary knee arthroplasties. A) Total; B) Partial. Source: RACat.***



Cumulative revision rate

The estimated cumulative revision rate for total and partial knee arthroplasties (with no adjustment) is shown in Table 22 and Table 23. For total knee arthroplasties, the 1-year revision rate was 0.89%, rising to 3.8% at 5-year and 5.1% at 9-years after the primary surgery. For partial knee arthroplasties, the rate was 2.0% and 10.2% at the 1-year and 5-year after the primary surgery, respectively.

The risk of revision both for patients who underwent total and partial knee arthroplasty was adjusted by sex, age, and comorbidities. A higher risk of revision was observed in groups of younger patients. The Cox model fitted for total knee arthroplasties revealed an increased risk of revision for patients under 65 years and for patients aged between 65 and 75 years compared to those aged 85 years or over (HR=3.34 (IC95%: 1.96-5.70); HR=2.02 (IC95%: 1.19-3.43); data not shown). A similar trend was observed for partial knee arthroplasties, although differences were not statistically significant (data not shown).

The cumulative revision rate by fixation technique (without adjustment) for total knee arthroplasties revealed that cemented and hybrid prostheses showed the lowest revision rate at 1-year (0.8% and 0.7%, respectively), whereas the 1-year revision rate for cementless prosthesis was 3.0% (Table 24, Figure 12). For partial knee arthroplasties, the cumulative revision rate for cemented prosthesis was 2.0% at 1-year follow up, rising to 7.4% and 10.1% at 3- and 5-year follow-up, respectively (Table 25). Estimating the risk of revision of total knee arthroplasties per fixation technique using a Cox model (adjusted by sex, age and comorbidities), revelated a higher risk of revision of cementless and inverse hybrid arthroplasties in comparison with cemented arthroplasties (HR=2.00 (IC95%: 1.43-2.81); HR=1.58 (IC95%: 1.01-2.46), respectively). However, the risk of revision was lower among prosthesis using hybrid fixation (HR=0.69 (IC95%: 0.59-0.81; data not shown).

Table 26 shows the cumulative revision rates for CR and PS, the two most common types of total knee arthroplasty. The data shows that the cumulative rate at 1- and 3-year of follow-up is quite similar between both arthroplasty types. However, the 9-year cumulative rate was somewhat higher for PS in comparison to CR. The cumulative revision rate for partial knee arthroplasties revealed that 1-year revision rate for unicompartmental arthroplasties was 2.1%, increasing up to 7.0% and 9.3% at 3- and 5-year follow-up, respectively (Table 27). Risk of revision adjusted by sex, age and comorbidities for CR and PS arthroplasties revealed no differences in the risk of revision for both types of arthroplasties (data not shown).

We estimated the cumulative incidence of replacement considering death as a competitive event, both for partial and total knee arthroplasties. Figure 13 shows two functions: one with the cumulative risk of revision adjusted by age, sex, comorbidity and patient death probability, and the other adjusted by the same variables without considering the competitive risk of death. It can be observed that both curves are quite similar, the cumulative incidence function without adjustment by competitive risk of death slowly growing apart from the other curve. Even though the difference is not very significant, it increases over time and 4-5 years after the intervention, the difference becomes more evident. For total knee arthroplasty, the cumulative incidence of revision, adjusted by age, sex, and comorbidity at 5 years was 4.02% and considering competitive risk of death, 3.99%. For partial knee arthroplasties, the cumulative incidence of revision, adjusted by age, sex, and comorbidity at 5 years was 10.74% and considering competitive risk of death, 10.65%

Table 22. ***Estimated cumulative revision rate after a primary total knee arthroplasty. Source: RACat-MBD-SHD-RCA***

Time	Primary arthro-plasty	Revisions	Cumulative revision rate (%)	CI 95%	
30 days	45,019	76	0.17	0.13	0.21
90 days	43,934	101	0.39	0.34	0.46
1 year	40,289	209	0.89	0.81	0.98
3 years	28,832	671	2.77	2.61	2.94
5 yeas	16,812	266	3.84	3.63	4.05
7 years	7,546	91	4.53	4.29	4.79
9 years	790	26	5.17	4.76	5.63

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

Table 23. ***Estimated cumulative revision rate after a primary partial knee arthroplasty. Source: RACat-MBD-SHD-RCA.***

Time	Primary arthro-plasty	Revisions	Cumulative Revision rate (%)	CI 95%	
30 days	1,387	1	0.07	0.01	0.51
90 days	1,339	1	0.15	0.04	0.58
1 year	1,134	22	2.07	1.41	3.02
3 years	706	54	7.55	6.1	9.34
5 years	391	18	10.24	8.42	12.43
7 years	*136*	*4*	*11.6*	*9.44*	*14.22*
9 years	12	2	.	.	.

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register
Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Table 24. ***Estimated cumulative revision rate after a primary total knee arthroplasty by fixation technique. Source: RACat- MBDSHD-RCA***

Time	Primary arthroplasty	Revisions	Cumulative Revision rate (%)	CI 95%	
Cemented					
30 days	34,145	60	0.18	0.14	0.23
90 days	33,296	77	0.40	0.34	0.47
1 year	30,428	143	0.86	0.77	0.97
3 years	21,380	515	2.8	2.61	3
5 years	12,113	207	3.92	3.69	4.18
7 years	5,535	73	4.7	4.4	5.01
9 years	379	22	5.62	4.95	6.37
Cementless					
30 days	400	0	0.00	.	.
90 days	400	0	0.00	.	.
1 year	385	12	3.02	1.73	5.26
3 years	316	17	7.5	5.27	10.62
5 years	*171*	*6*	*9.5*	*6.89*	*13.02*
7 years	51	0	.	.	.
9 years	1	0	.	.	.
Hybrid					
30 days	6,669	6	0.09	0.04	0.2
90 days	6,564	8	0.21	0.12	0.35
1 year	6,176	30	0.68	0.51	0.91
3 years	5,014	87	2.18	1.84	2.58
5 years	3,417	32	2.87	2.46	3.34
7 years	1,622	12	3.31	2.84	3.85
9 years	385	4	3.61	3.07	4.25
Inverse Hybrid					
30 days	344	0	0.00	.	.
90 days	336	1	0.29	0.04	0.21
1 year	313	5	1.83	0.83	4.04
3 years	211	10	5.68	3.5	9.16
5 years	*109*	*4*	*7.93*	*5.1*	*12.23*
7 years	12	0	.	.	.
9 years	1	0	.	.	.

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Figure 12. ***Estimated cumulative revision rate after a primary total knee arthroplasty by fixation technique. Source: RACat-MBDSHD-RCA***

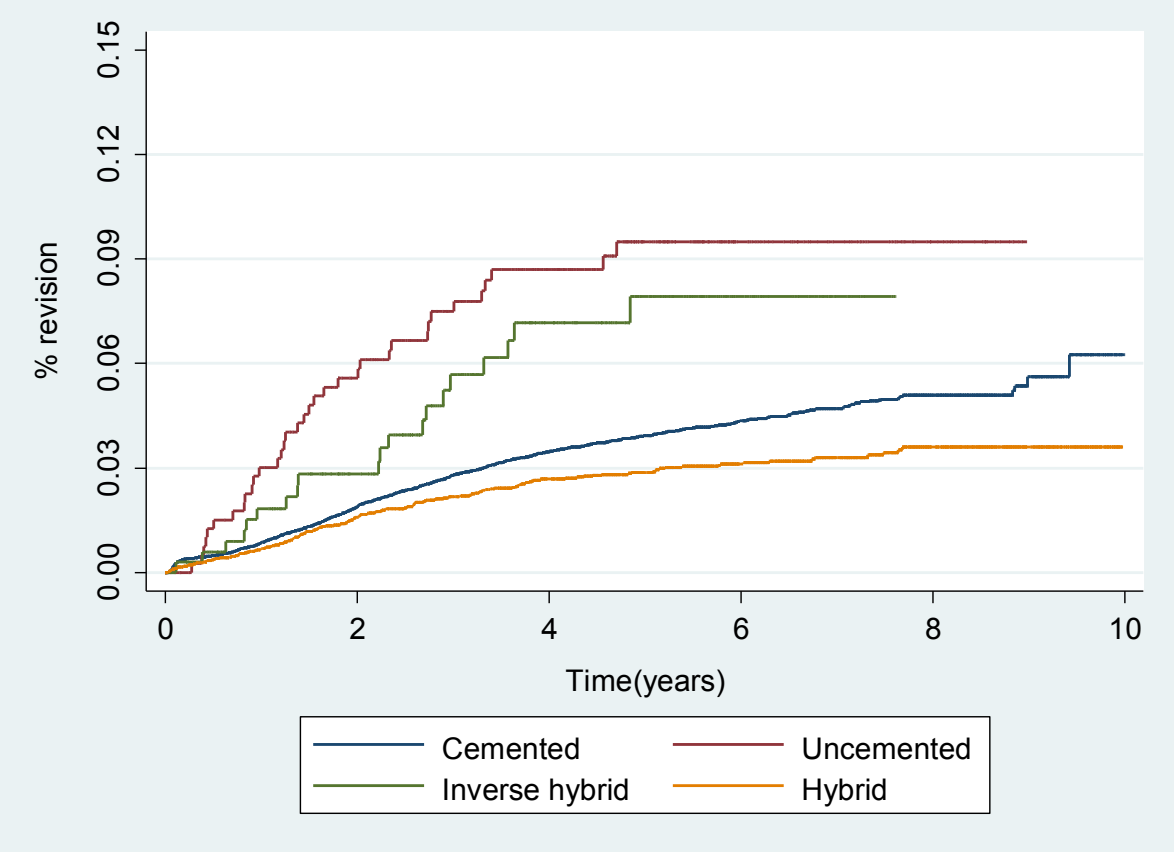


Table 25. ***Estimated cumulative revision rate after a primary partial knee arthroplasty by fixation technique. Source: RACat- MBDSHD-RCA***

Time	Primary arthro-plasty	Revisions	Cumulative Revision rate (%)	CI 95%	
Cemented					
30 days	1,348	1	0.07	0.01	0.52
90 days	1,301	1	0.15	0.04	0.6
1 year	1,101	23	2.05	1.39	3.02
3 years	687	52	7.45	5.99	9.25
5 years	384	17	10.05	8.23	12.25
7 years	*132*	*4*	*11.45*	*9.27*	*14.1*
9 years	12	2	.	.	.

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

The number of patients at risk for the other fixation categories was <100; the estimates were not calculated since they were very unreliable.

Table 26. ***Estimated cumulative revision rate after a primary total knee arthroplasty (CR/PS)***

Time, in years	Primary arthro-plasty	Revisions	Cumulative Revision rate (%)	CI 95%	
CR					
30 days	21,017	25	0.12	0.08	0.18
90 days	20,477	47	0.34	0.27	0.43
1 year	18,633	40	0.91	0.78	1.05
3 years	13,155	306	2.76	2.53	3.02
5 years	7,516	113	3.78	3.48	4.1
7 years	3,444	36	4.40	4.04	4.78
9 years	382	12	4.79	4.38	5.24
PS					
30 days	23,168	45	0.19	0.14	0.26
90 days	22,660	49	0.41	0.33	0.5
1 year	20,918	94	0.84	0.73	0.96
3 years	15,140	350	2.73	2.51	2.97
5 years	8,969	145	3.81	3.54	4.11
7 years	3,996	54	4.59	4.25	4.96
9 years	405	14	5.46	4.77	6.24

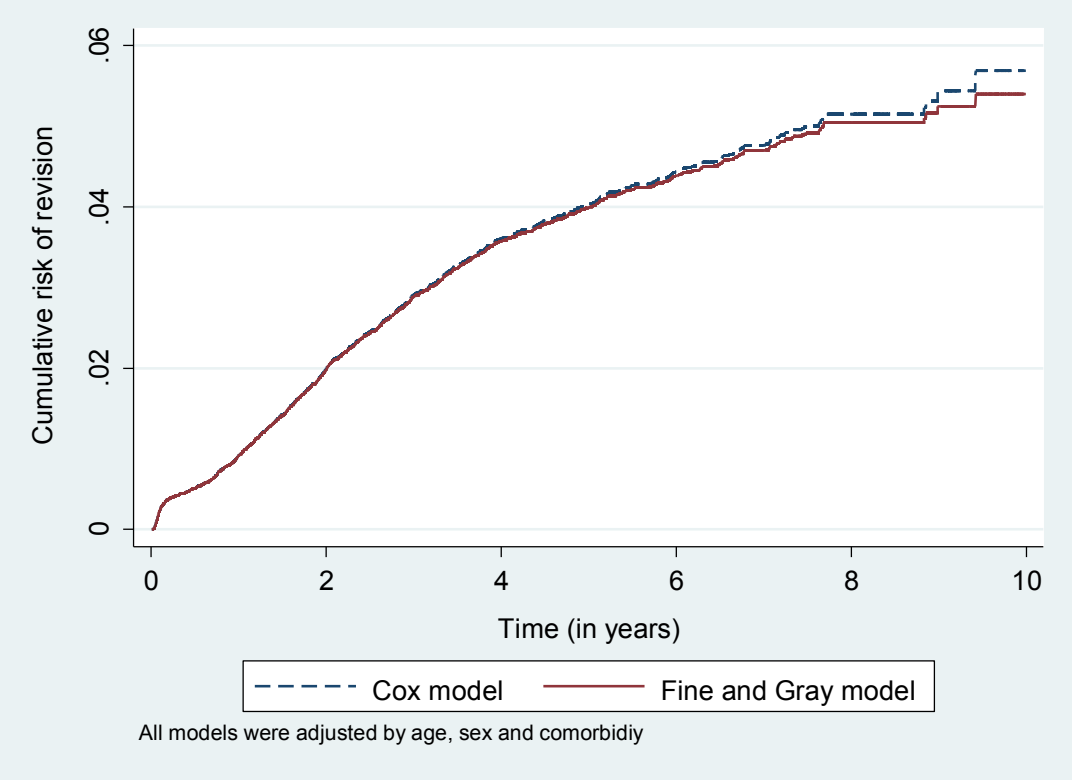
95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register
CR: Posterior cruciate retaining; PS: Posterior stabilized

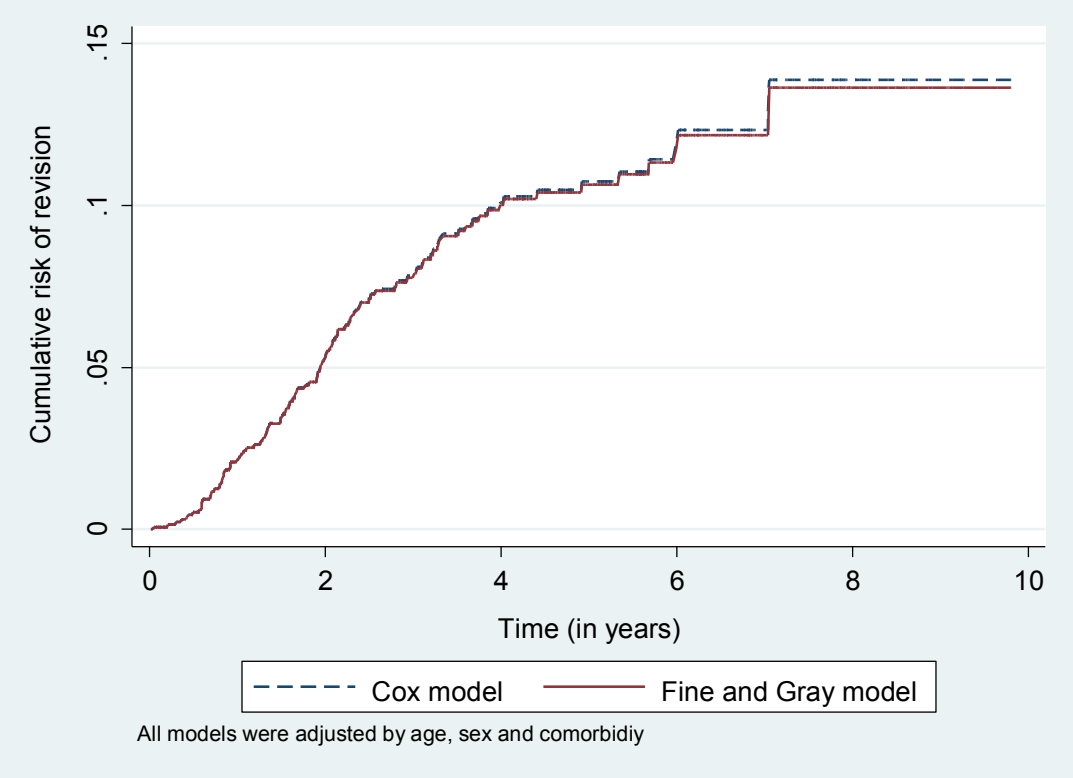
Table 27. ***Estimated cumulative revision rate after a primary partial knee arthroplasty (Unicompartmental/ Patellofemoral)***

Time	Primary arthro-plasty	Revisions	Cumulative Revision rate (%)	CI 95%	
Unicompartmental					
30 days	1,146	1	0.09	0.01	0.62
90 days	1,102	1	0.18	0.04	0.7
1 year	914	18	2.13	1.41	3.22
3 years	551	38	6.99	5.45	8.95
5 years	328	12	9.27	7.36	11.64
7 years	*121*	*4*	*10.88*	*8.54*	*13.82*
9 years	12	1	.	.	.
Patellofemoral					
30 days	229	0	0.00	.	.
90 days	226	0	0.00	.	.
1 year	*211*	*2*	*0.92*	*0.23*	*3.64*
3 years	*146*	*16*	*9.34*	*5.98*	*14.44*
5 years	57	5	.	.	.
7 years	17	0	.	.	.
9 years	1	1	.	.	.

CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register
Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Figure 13. ***Cumulative incidence of revision after a primary total and partial knee arthroplasty adjusted by competitive risk of death, sex and age. A) Total knee arthroplasty; B) Partial knee arthroplasty. Source: RACat-RCA***





5. Hip Arthroplasties results

5.1. Scope and quality of the data

In the period described, data from 46,488 patients with primary hip arthroplasty and from 5,237 patients with revision hip arthroplasty was received. The volume of data increased over time, suffering a slight decrease from 2012 onwards (Figure 14). The highest volume of primary and revision arthroplasties was registered in the health care region of Barcelona (Table 28).

Table 29 shows the volume of primary and revision arthroplasties sent during the study period, per centre. The overall burden of revision, understood as the percentage of revision arthroplasties compared to the total number of events sent, was 11.3%.

Figure 15 shows the completeness both for primaries and revisions over the study period. The data shows that the highest completeness was reached in 2011 and 2012. A gradual decrease was observed from 2012 onwards, coinciding with technical changes in data notification. Figure 16 shows the variability in data completeness of each centre (blue points) compared with overall completeness (green line) and a confidence interval based on overall completeness. The centres that are below the range of the confidence interval exhibit lower completeness compared to the overall figure, and the ones that are above exhibit higher completeness than the overall. Twelve out of the 53 centres fell below the confidence interval based on the overall reference value.

As shown in Table 30, in the latter period 77.1% of hip arthroplasties were classified. Figure 17 is a funnel plot which shows the percentage of classified primary arthroplasties per centre in relation to the volume of data sent in the period 2013-2014. It can be observed great variability between centres on the percentage of classified cases, most of them presenting percentages around 80%, which indicates good quality of the information sent.

The percentage of arthroplasties with reported laterality increased over the study period reaching in 2013-2014 a 97.6% (Table 31). Using data from the latest 2 years we plotted percentage of laterality reported per centre (Figure 18). In that case, the percentage of completeness for this variable is high in most centres.

Figure 14. ***Volume of hip arthroplasties sent to the RAcat per year. Source: RACat***

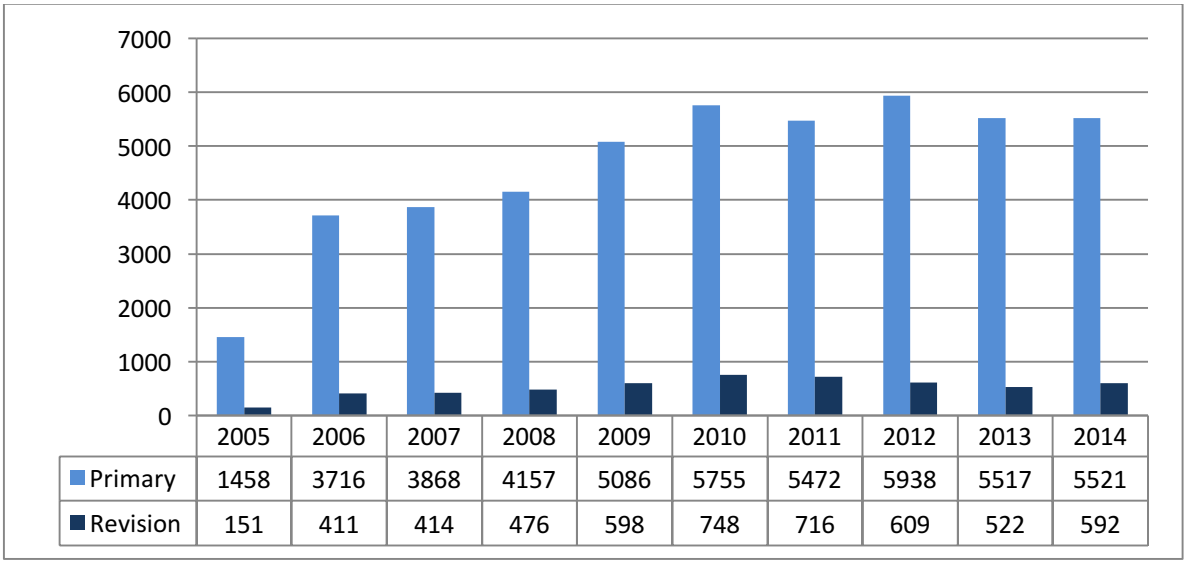


Table 28. ***Number of hip arthroplasties by health region, period and by type of arthroplasty. Source RACat.***

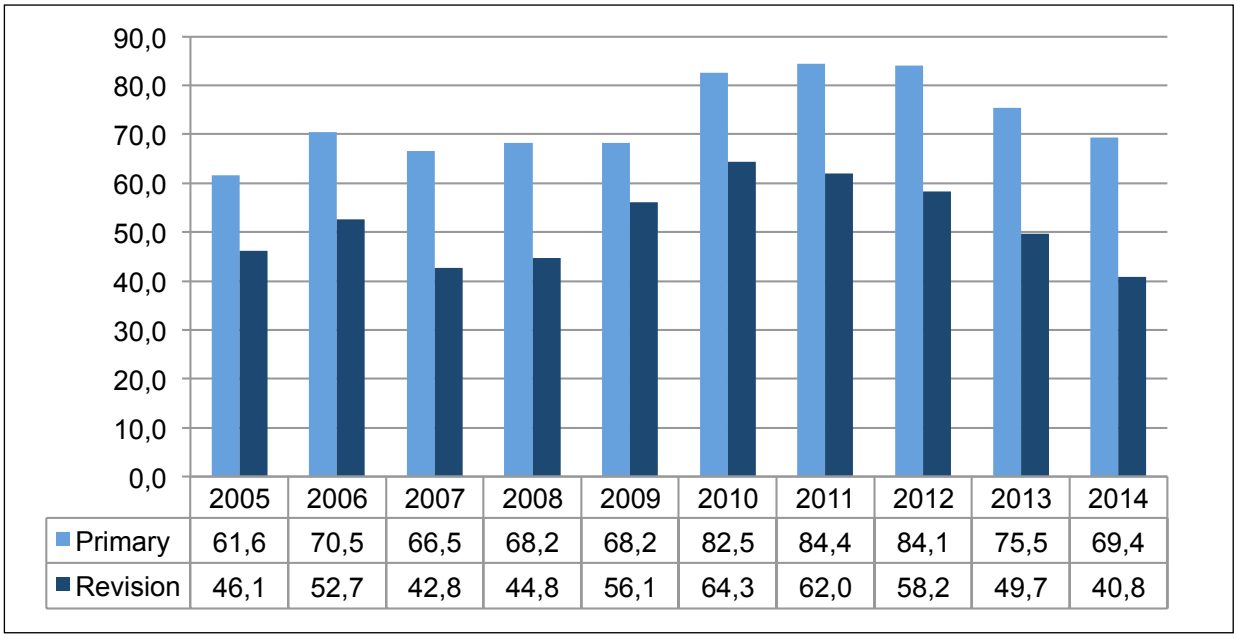
	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		All periods	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
Lleida	90	19	248	26	332	33	535	28	587	16	**1,792**	**122**
Camp de Tarragona	86	1	458	26	771	49	745	57	709	71	**2,769**	**204**
Terres de l'Ebre	0	1	0	0	275	23	276	18	324	24	**875**	**66**
Girona	924	80	1,217	133	1,429	168	1,435	159	1,423	107	**6,428**	**647**
Catalunya Central	438	58	880	94	972	134	1,065	101	1,141	97	**4,496**	**484**
Alt Pirineu i Aragó	116	5	104	7	111	8	122	6	103	4	**556**	**30**
Barcelona	3,520	398	5,118	604	6,951	931	7,232	956	6,751	795	**29,572**	**3,684**
Total	**5,174**	**562**	**8,025**	**890**	**10,841**	**1346**	**11,410**	**1325**	**11,038**	**1114**	**46,488**	**5,237**

Table 29. ***Number of hip arthroplasties by health care region, centre, period and by type of arthroplasty. Source RACat.***

Hospital	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
Lleida												
Hospital Universitari Arnau de Vilanova	0	0	0	0	78	14	303	7	309	0	**690**	**21**
Hospital de Santa Maria	70	16	171	13	153	13	108	14	178	7	**680**	**63**
Clínica de Ponent	20	3	77	13	101	6	124	7	100	9	**422**	**38**
Camp de Tarragona												
Hospital Universitari de Tarragona Joan XXIII	0	0	147	12	211	24	207	33	214	30	**779**	**99**
Hospital Universitari Sant Joan de Reus	0	0	70	0	302	0	293	0	122	0	**787**	**0**
Hospital de Sant Pau i Santa Tecla	19	0	64	3	79	16	81	11	123	8	**366**	**38**
Pius Hospital de Valls	48	1	106	3	100	6	92	6	94	4	**440**	**20**
Hospital del Vendrell	19	0	71	8	79	3	72	7	156	29	**397**	**47**
Terres de l´Ebre												
Hospital Tortosa Verge de la Cinta	0	1	0	0	275	23	219	18	270	24	**764**	**66**
Hospital Comarcal Móra d'Ebre	0	0	0	0	0	0	57	0	54	0	**111**	**0**
Girona												
Hospital Universitari de Girona Josep Trueta	0	0	235	49	270	52	261	46	284	9	**1,050**	**156**
Clínica Girona SA	0	0	0	0	39	4	73	7	0	0	**112**	**11**
Clínica Salus Infirmorum	0	0	0	0	0	0	0	0	42	1	**42**	**1**
Hospital Comarcal de Blanes	298	24	306	36	298	24	270	15	325	24	**1,497**	**123**
Hospital de Campdevanol	38	2	41	1	41	0	48	1	52	0	**220**	**4**
Hospital de Figueres	107	8	257	15	278	32	247	38	113	11	**1,002**	**104**
Hospital de Palamós	204	20	226	16	193	21	195	23	212	34	**1,030**	**114**
Hospital de Sant Jaume d'Olot	146	16	36	2	131	13	150	18	164	14	**627**	**63**
Hospital Provincial Santa Caterina	131	10	116	14	179	22	191	11	231	14	**848**	**71**
Catalunya Central												
Centre Hospitalari-ALTHAIA	203	42	452	63	451	98	470	80	506	71	**2,082**	**354**
Hospital General de Vic	129	2	161	1	237	3	314	2	400	0	**1,241**	**8**
Hospital de Sant Bernabé	0	0	41	3	74	9	85	2	107	15	**307**	**29**
Fundació Sanitaria d'Igualada FP	106	14	226	27	210	24	196	17	128	11	**866**	**93**
Alt Pirineu i Aran												
Fundació Sant Hospital de la Seu d'Urgell	32	2	35	0	44	1	45	3	39	2	**195**	**8**
Hospital Comarcal del Pallars	30	2	34	6	26	3	27	2	8	2	**125**	**15**
Hospital de Puigcerdà	54	1	35	1	41	4	50	1	56	0	**236**	**7**

Hospital	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
Barcelona												
Hospital de Viladecans	0	0	0	0	74	21	160	21	190	4	**424**	**46**
Hospital Universitari de Bellvitge	358	0	287	0	438	8	203	15	194	5	**1,480**	**28**
H.Universitari Germans Trias i Pujol	0	0	10	3	186	37	237	18	334	3	**767**	**61**
Hospital Clinic i Provincial de Barcelona	703	109	639	68	780	133	701	126	593	132	**3,416**	**568**
Hospital de L'Hospitalet - CSI	275	29	227	23	337	43	303	53	366	22	**1,508**	**170**
Hospital Dos de Maig de Barcelona - CSI	75	6	64	14	150	18	187	21	201	15	**677**	**74**
Hospital Mútua de Terrassa	0	0	256	51	363	74	304	54	90	21	**1,013**	**200**
Hospital de l'Esperit Sant	61	31	133	21	232	21	199	23	198	39	**823**	**135**
Corporació Sanitária Parc Taulí	184	35	431	96	451	92	422	92	276	61	**1,764**	**376**
Hospital de Sant Boi- Parc Sanitari St Joan de Deu	92	7	134	5	145	13	170	20	223	19	**764**	**64**
Hospital de Sant Celoni - Fundació privada	70	5	118	3	93	5	81	1	138	2	**500**	**16**
Hospital de Terrassa	0	0	184	36	223	39	211	23	259	40	**877**	**138**
Parc de Salut del Mar	95	12	0	0	506	57	674	110	0	0	**1,275**	**179**
Hospital General de Granollers	191	25	237	25	66	5	335	23	237	66	**1,066**	**144**
Hospital Municipal de Badalona	160	14	167	10	132	14	160	14	112	11	**731**	**63**
Hospital Residència Sant Camil	192	35	188	51	207	30	212	27	204	20	**1,003**	**163**
Hospital Sant Joan de Déu de Martorell	70	14	161	51	195	22	161	21	139	12	**726**	**120**
Hospital de Sant Joan de D`Esplugues Llob	0	0	0	0	0	0	0	1	0	0	**0**	**1**
Hospital Sant Rafael	0	0	0	0	179	53	155	30	134	30	**468**	**113**
F.G.S. Hospital de la Santa Creu i Sant Pau	0	0	1	0	362	44	664	82	728	90	**1,755**	**216**
H. de Plató	0	0	87	6	98	11	35	3	68	4	**288**	**24**
Hospital Universitari Sagrat Cor	244	32	392	43	371	40	380	45	402	102	**1,789**	**262**
Fundació Privada Hospital de Mollet	129	6	95	3	102	7	175	7	199	3	**700**	**26**
Hospital Comarcal de l'Alt Penedes	1	0	146	30	163	20	184	24	177	26	**671**	**100**
Hospital de Mataro	145	38	281	64	366	56	327	62	373	38	**1,492**	**258**
H. Universitari Vall d'Hebron	475	0	880	1	732	68	592	40	916	30	**3,595**	**139**
Total	**5,174**	**562**	**8,025**	**890**	**10,841**	**1,346**	**1,141**	**1,325**	**11,038**	**1,114**	**46,488**	**5,237**

Figure 15. ***Completeness of data sent to the RACat per year, and by type of arthroplasty. Source RACat-MBD-SHD***



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Primary	61,6	70,5	66,5	68,2	68,2	82,5	84,4	84,1	75,5	69,4
Revision	46,1	52,7	42,8	44,8	56,1	64,3	62,0	58,2	49,7	40,8

Figure 16. ***Percentage of completeness of primary hip arthroplasties per centre during the period 2013-2014. Source: RACat***

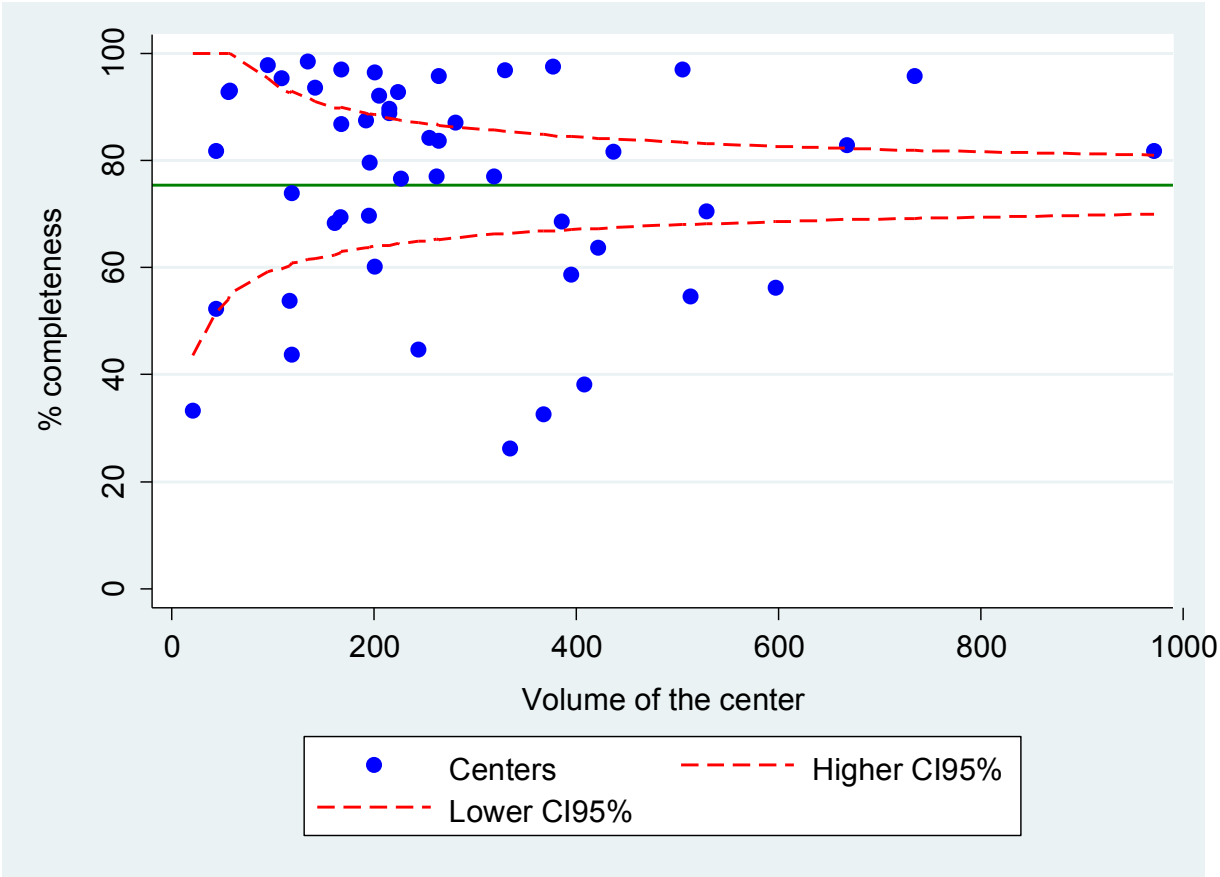


Table 30. ***Number and percentages of classified primary hip arthroplasties reported by period. Source RACat***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Classified	2,916	56.4	5,872	73.2	8,889	82.0	9,839	86.2	8,509	77.1	**36,025**	**77.5**
Not classified	2,258	43.6	2,153	26.8	1,952	18.0	1,571	13.8	2,529	22.9	**10,463**	**22.5**
Total	**5,174**	**100.0**	**8,025**	**100.0**	**10,841**	**100.0**	**11,410**	**100.0**	**11,038**	**100.0**	**46,488**	**100.0**

Figure 17. ***Percentage of primary hip arthroplasties classified per centre according to the volume of data sent in the period 2013-2014. Source: RACat.***

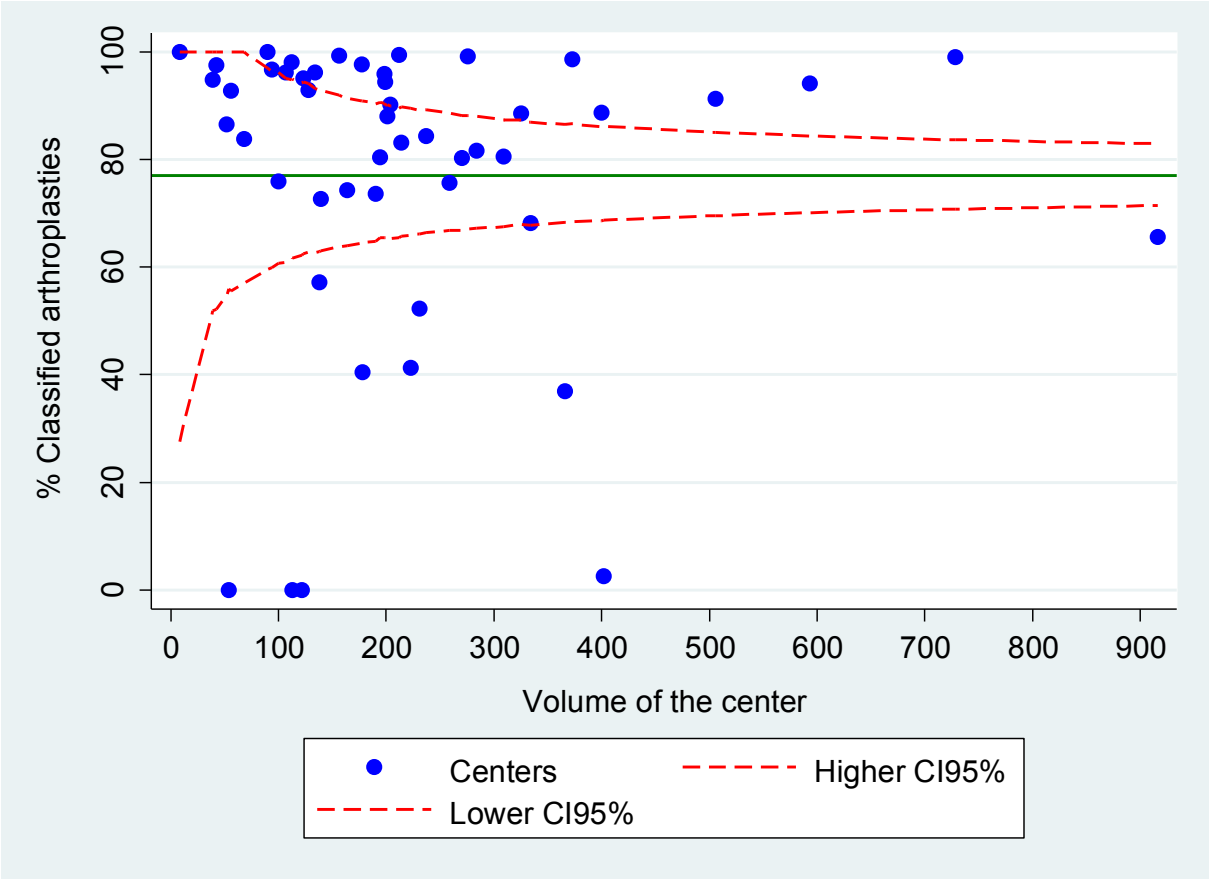
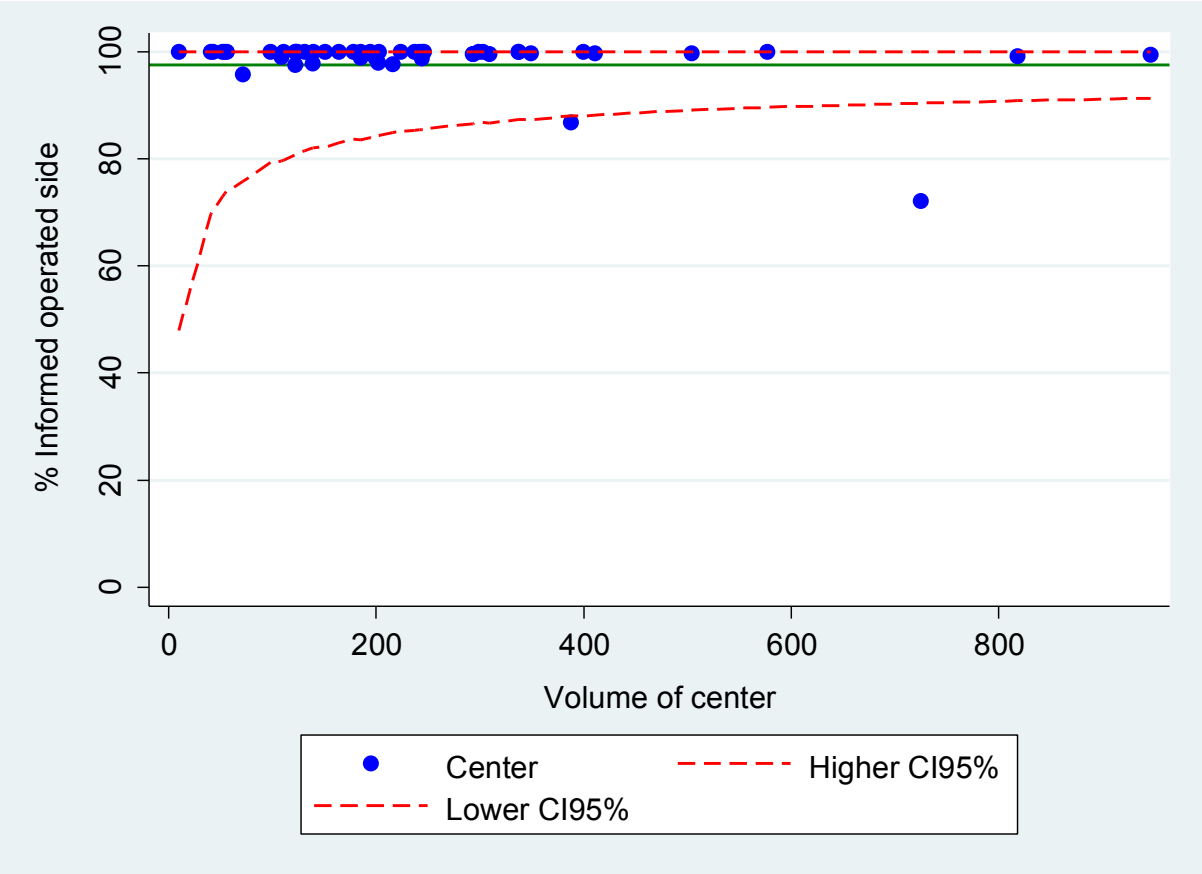


Table 31. ***Number of hip arthroplasties with the operated side (left or right) reported by period. Source RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Reported operated side	2,378	41.5	1,806	20.3	541	4.4	73	0.6	296	2.4	**5094**	**9.9**
Not reported	3,358	58.5	7,109	79.7	11,646	95.6	12,662	99.4	11,856	97.6	**46,631**	**90.2**
Total	**5,736**	**100.0**	**8,915**	**100.0**	**12,187**	**100.0**	**12,735**	**100.0**	**12,152**	**100.0**	**51,725**	**100.0**

Figure 18. ***Percentage of primary and revision hip arthroplasty with operated side informed per centre, and in relation to data volume sent in the period 2013-2014. Source: RACat***



5.2. Demographic and patient treatment process profile

From this section onwards the results are presented by total and partial hip arthroplasties.

The average age of patients who underwent a total hip arthroplasty was 68.5 years (standard deviation; SD: 11.2) and 84.8 years (SD: 7.2) for those underwent a partial hip arthroplasty; women 52.1% and 75.9% men respectively (Table 32 and Table 33).

In the time period spanning between 2005 and 2014, the age group distribution among patients undergoing a total hip arthroplasty and partial hip arthroplasty remained relativel unchanged (Figure 19). Over 80% of patients undergoing partial hip arthroplasty were aged 75 years or older.

Table 34 and Table 35 show the demographic and patient treatment profile of patients who experienced a hip arthroplasty by study periods. The data shows that the main reason for intervention of total hip arthroplasties was osteoarthritis, whereas fracture was the main cause of intervention for partial hip arthroplasties. Mechanical complications were the main cause for revision both for total and partial hip arthroplasties. As expected by differences in patient's age distribution, the percentage of patients with 1 or more comorbidities was higher for patients undergoing partial hip arthroplasties in comparison to those undergoing a total hip arthroplasty.

Table 32. ***Age and sex of patients undergoing a primary total hip arthroplasty by health care region and period. Source: RACat***

	2005/2006			2007/2008			2009/2010			2011/2012			2013/2014			Total	
Health care region	n	Mean age (SD)	% women	n	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	n	Mean age (SD)	% women
Lleida	80	69.2 (10.8)	40.0	183	67.1 (11.8)	42.1	259	66.8 (11.7)	46.7	254	70.2 (11.0)	46.5	269	69.5 (11.6)	44.2	1,045	**68.9 (11.6)**	**44.9**
Camp de Tarragona	45	70.9 (9.2)	51.1	241	67.2 (12.2)	50.6	339	67.7 (13.0)	45.7	317	68.0 (11.7)	46.1	398	67.4 (12.0)	49.8	1,340	**67.8 (12.2)**	**48.0**
Terres de l'Ebre	0	0	0.0	0	0	0.0	181	67.1 (13.5)	47.0	108	65.9 (13.4)	50.9	126	66.2 (10.8)	50.8	415	**68.5 (12.7)**	**49.0**
Girona	493	70.7 (10.4)	56.2	591	70.6 (11.2)	56.0	656	70.3 (12.0)	55.3	625	69.8 (12.0)	51.0	704	69.3 (11.2)	50.6	3,069	**70.1 (11.5)**	**53.6**
Catalunya centra	164	70.1 (10.7)	48.2	451	69.4 (10.7)	49.5	502	68.6 (12.8)	50.0	567	68.1 (11.9)	47.3	628	68.1 (11.5)	46.5	2,312	**68.7 (11.8)**	**48.4**
Alt Pirineu i Aran	64	73.7 (9.4)	60.9	72	71.7 (9.9)	55.6	73	75.2 (11.0)	63.0	58	70.7 (11.4)	43.1	65	70.5 (10.7)	49.2	332	**72.5 (10.5)**	**54.7**
Barcelona	1,175	68.2 (11.5)	54.8	2,448	68.5 (12.3)	54.2	3,733	68.0 (12.6)	53.2	4,199	68.5 (12.4)	53.6	3,244	67.8 (12.6)	51.5	14,799	**68.3 (12.5)**	**53.3**
Total	2,021	69.3 (11.1)	54.1	3,986	68.8 (12.0)	53.2	5,743	68.3 (112.6)	52.3	6,128	68.6 (12.3)	51.9	5,434	68.1 (12.2)	50.3	23,312	68.5 (11.2)	52.1

Table 33. ***Age and sex of patients undergoing a primary partial hip arthroplasty by health care region and period. Source: RACat***

	2005/2006			2007/2008			2009/2010			2011/2012			2013/2014			Total	
	n	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	N	Mean age (SD)	% women	n	Mean age (SD)	% women
Lleida	4	86.6 (4.9)	100.0	7	86.1 (9.9)	100.0	12	84.6 (3.6)	83.3	170	84.6 (7.8)	81.8	128	85.1 (6.7)	74.2	321	**84.8 (7.2)**	**79.4**
Camp de Tarragona	36	84.6 (7.5)	80.6	98	84.0 (8.3)	73.5	100	83.8 (8.2)	69.0	114	85.1 (6.8)	76.3	143	85.6 (7.5)	70.6	491	**84.7 (7.6)**	**72.9**
Terres de l'Ebre	0	0	0.0	0	0	0.0	86	84.5 (5.1)	83.7	103	83.8 (6.5)	78.6	91	85.3 (5.6)	79.1	280	**84.5 (5.8)**	**80.4**
Girona	140	85.8 (6.2)	78.6	90	86.5 (5.2)	81.1	212	84.9 (7.1)	75.9	320	84.8 (6.6)	79.1	356	84.9 (7.8)	75.6	1,118	**85.1 (7.0)**	**77.5**
Catalunya central	114	83.4 (6.5)	76.3	294	83.8 (6.7)	75.5	353	84.0 (7.4)	77.6	429	84.6 (7.4)	73.0	411	84.8 (6.9)	74.0	1,601	**84.3 (7.1)**	**75.0**
Alt Pirineu i Aran	16	83.2 (8.4)	68.8	23	86.8 (6.2)	87.0	31	86.7 (7.0)	67.7	59	84.5 (9.1)	76.3	32	84.0 (7.4)	81.3	161	**85.5 (7.9)**	**76.4**
Barcelona	585	84.0 (7.4)	76.9	1,374	84.2 (7.2)	78.2	2,352	84.4 (7.2)	74.9	2,516	85.3 (7.0)	75.8	1,914	85.4 (7.3)	74.7	8,741	**84.6 (7.2)**	**75.8**
Total	895	84.2 (7.1)	77.2	1,886	84.3 (7.1	77.8	3,146	84.4 (7.2)	75.3	3,711	85.1 (7.1)	76.1	3,075	85.3 (7.3)	74.7	12,713	84.8 (7.2)	75.9

Figure 19. ***Age of patients undergoing a hip arthroplasty by period. A) Total hip arthroplasty; B) Partial hip arthroplasty. Source: RACat***

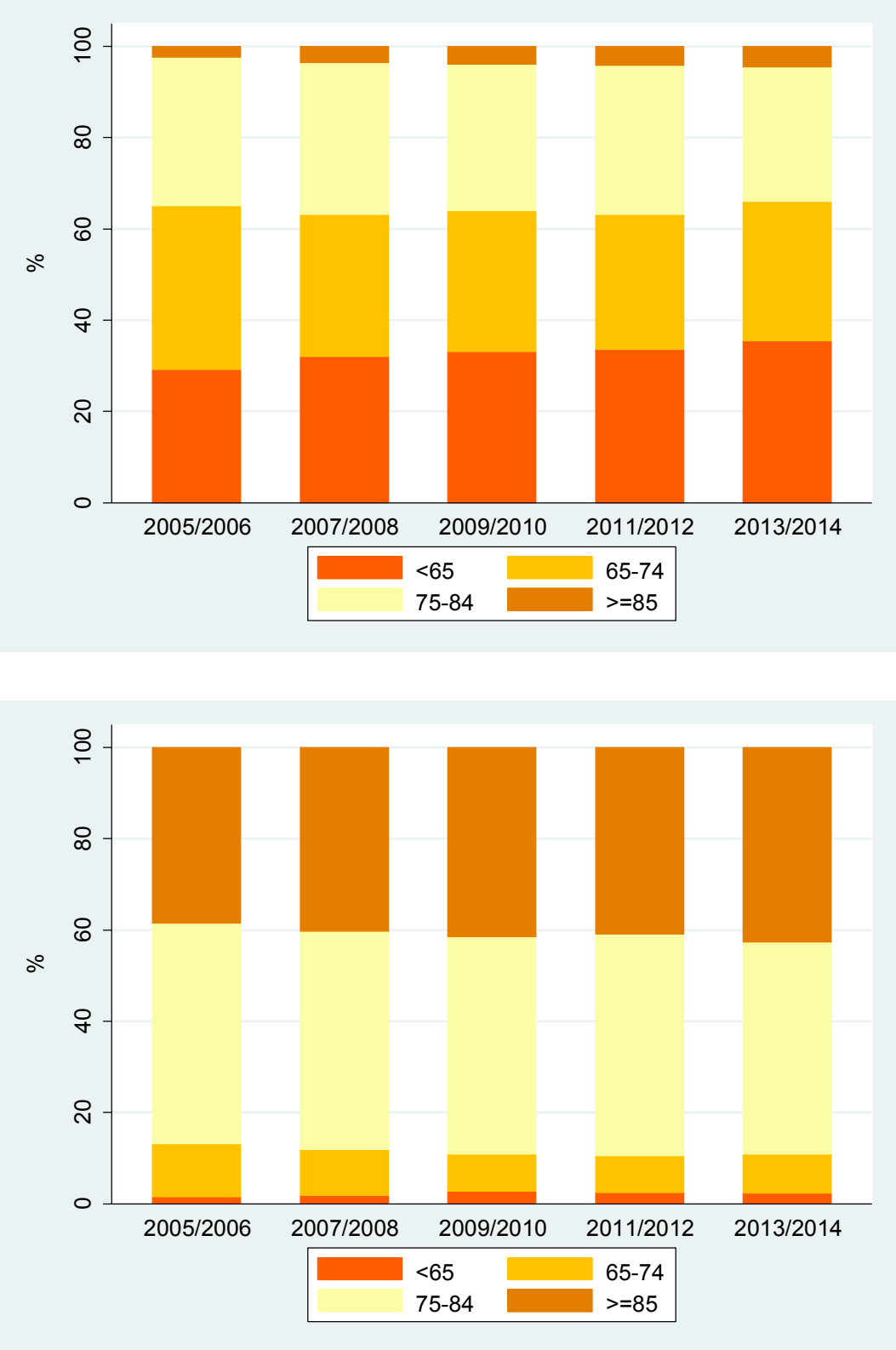


Table 34. ***Demographic and patient treatment profile of patients with primary and revision total hip arthroplasty by period. Source RACat-MBDSHD***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Number	1,844 (100)	78 (100)	3,765 (100)	118 (100)	5,453 (100)	246 (100)	5,958 (100)	207 (100)	5,211 (100)	128 (100)
% of Women	1,002 (4.3)	47 (60.3)	1,996 (53.0)	72 (61.0)	2,857 (52.4)	1,133 (54.1)	3,085 (51.8)	115 (55.6)	2,615 (50.2)	69 (53.9)
Mean age (SD)	69.3 (11.0)	73.0 (12.2)	68.8 (12.0)	73.7 (12.1)	68.4 (12.5)	73.4 (11.2)	68.5 (12.2)	72.7 (12.4)	68.0 (12.1)	72.9 (12.2)
Cause of intervention										
Osteoarthritis	1,431 (77.6)	0	3,008 (79.9)	0	4,418 (81.0)	0	4,810 (80.7)	0	4,256 (81.7)	0
Fracture	228 (12.4)	0	394 (10.5)	0	565 (10.4)	0	654 (11.0)	0	481 (9.2)	0
Other diagnostics	185 (10.0)	0	363 (9.6)	0	470 (8.6)	0	494 (8.3)	0	474 (9.1)	0
Cause of revision										
Mechanical complications	0	54 (69.2)	0	81 (68,6)	0	170 (69.1)	0	149 (72,0)	0	80 (62.5)
Infection	0	9 (11.5)	0	8 (6.8)	0	30 (12.2)	0	21 (10.1)	0	21 (16.4)
Other diagnostics	0	15 (19.2)	0	29 (24.6)	0	46 (18.7)	0	37 (17.9)	0	27 (21.1)
Comorbidity										
1 or more	955 (51.8)	44 (56.4)	1,927 (51.2)	66 (55.9)	3,205 (58.8)	166 (67.5)	3,752 (63.0)	139 (67.2)	3,329 (63.9)	88 (68.8)
Healthcare discharge	162 (8.8)	9 (11.5)	317 (8.4)	21 (17.8)	562 (10.3)	54 (22.0)	763 (12.8)	44 (21.3)	652 (12.5)	31 (24.2)

Table 35. ***Demographic a nd patient treatment profile of patients with primary and revision partial hip arthroplasty by period. Source RACat-MBDSHD***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Number	790 (100)	2 (100)	1,817 (100)	13 (100)	2,953 (100)	18 (100)	3,659 (100)	16 (100)	2,973 (100)	13 (100)
% of Women	612 (77.5)	2 (100)	1,419 (78.1)	7 (53.9)	2,222 (75.3)	14 (77.8)	2,788 (76.2)	10 (62.5)	2,228 (74.9)	11 (84.6)
Mean age (SD)	84.2 (7.0)	91.3 (3.1)	84.4 (7.0)	79.8 (8.0)	84.5 (7.2)	82.8 (9.4)	85.1 (7.1)	85.0 (7.1)	85.3 (7.2)	84.7 (6.0)
Cause of intervention										
Fracture	752 (95.2)	0	1,724 (94.9)	0	2,799 (94.8)	0	3,504 (95.8)	0	2,841 (95.6)	0
Other diagnostics	38 (4.8)	0	93 (5.1)	0	154 (5.2)	0	152 (4.3)	0	132 (4.4)	0
Cause of revision										
Mechanical complications	0	1 (50.0)	0	7 (53.9)	0	14 (77.8)	0	10 (62.5)	0	6 (46.2)
Infection	0	0	0	4 (30.8)	0	1 (5.6)	0	2 (12.5)	0	6 (46.2)
Other diagnostics	0	1 (50.0)	0	2 (15.4)	0	3 (16.7)	0	4 (25.0)	0	1 (7.69)
Comorbidity										
1 or more	560 (70.9)	1 (50.0)	1,356 (74.6)	7 (53.9)	2,289 (77.5)	16 (88.9)	3,047 (83.3)	14 (87.5)	2,057 (84.3)	11 (84.6)
Healthcare discharge	191 (24.2)	1 (50.0)	475 (26.1)	0 (0.0)	945 (32.0)	3 (16.7)	1,342 (36.7)	6 (37.5)	1,253 (42.2)	6 (46.6)

5.3. Characteristics of primary arthroplasties

30,031 hip arthroplasties could be classified for the whole study period. Total hip arthroplasties represented 77.6% whereas partial arthroplasties represented 22.4%. Within total hip arthroplasties, the most common implants were the conventional prosthesis, representing over 95% of arthroplasties. Bipolar and unipolar monoblock were the most common types of partial prosthesis, representing 46.7% and 47.2% of partial arthroplasties, respectively (Table 36).

Conventional total hip arthroplasties were the most common arthroplasty type across age groups. However, for partial hip arthroplasties, the use of bipolar prosthesis decreased proportionally as age increased, whereas the opposite pattern was observed for unipolar monoblock prosthesis (Figure 20).

Almost 65% of total hip arthroplasties were cementless, this type of fixation showing an increasing trend over time (Figure 21). The proportion of cemented and cementless prosthesis for partial hip arthroplasties was 49.5% and 50.5%, respectively. (Table 37, Table 38, and Figure 21). Among total hip arthroplasties, the percentage of cementless prosthesis was higher for men than for women (73.1% and 57.4%, respectively) (Table 39). Regarding partial hip arthroplasties, the distribution of type of fixation for men and women was quite similar (Table 40).

Table 41 and Table 42 show the distribution of type of fixation technique by age groups, for total and partial arthroplasties, respectively. For total fixation techniques, the data shows that the percentage of cementless prostheses decreased proportionally as age increased. However, for partial hip arthroplasties, the older the patients, the higher the percentage of cementless prostheses.

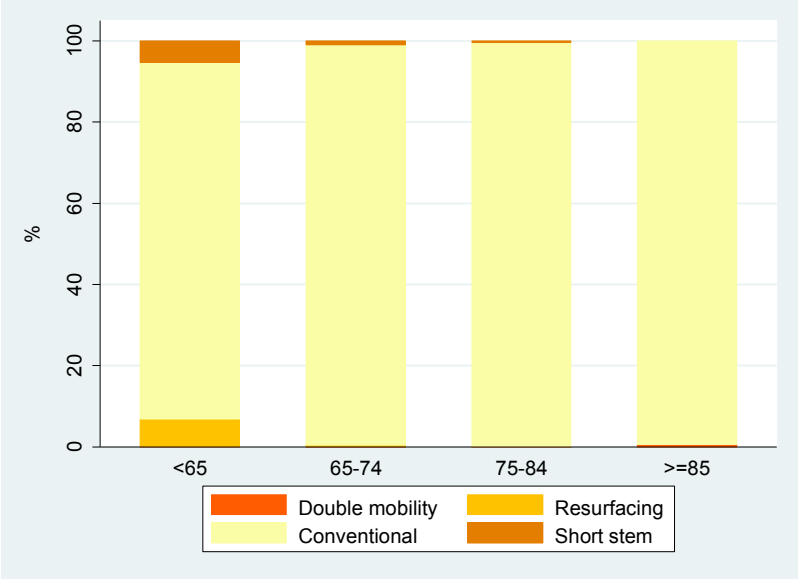
In conventional total hip arthroplasties, the most commonly used friction device was metal-polyethylene (65.8%). This type of friction device was the most common in all age groups, even though there was more variability in the friction device used among patients under 65 (Table 43).

Head size distribution for total conventional hip arthroplasties by friction devices revealed that small heads (<32mm) were commonly used among Metal on Polyethylene and Ceramic on Polyethylene implants (72.7% and 68.1%, respectively). Medium heads were the most common among Ceramic on Ceramic arthroplasties (71%). Among Metal on Metal prosthesis, small heads represented 43.3% and large heads 35.7% (Table 44).

Table 36. ***Number of primary hip arthroplasties per type of arthroplasty and period. Source: RACat.***

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Total Hip Arthroplasty												
Double mobility	0	0.00	0	0.00	2	0.03	14	0.2	15	0.3	**31**	**0.1**
Resurfacing	23	1.1	124	3.1	234	4.1	121	2.0	46	0.9	**548**	**2.4**
Conventional	1,996	98.8	3,835	96.2	5,382	93.7	5,841	95.3	5,176	95.3	**22,230**	**95.4**
Short stem	2	0.1	27	0.7	125	2.2	152	2.5	197	3.6	**503**	**2.2**
Partial Hip Arthroplasty												
Bipolar	339	37.9	818	43.4	1,617	51.4	1,668	45	1,491	48.5	**5,933**	**46.7**
Unipolar modular	96	10.7	132	7.0	231	7.3	207	5.6	114	3.7	**780**	**6.14**
Unipolar monoblock	460	51.4	936	49.6	1,298	41.3	1,836	49.5	1,470	47.8	**6,000**	**47.2**
Not specified	2,258	100.0	2,153	100.0	1,952	100.0	1,571	100.0	2,529	100.0	**10,463**	**100.0**
Total	**5,174**	**100.0**	**8,025**	**100.0**	**10,841**	**100.0**	**11,410**	**100.0**	**11,038**	**100.0**	**46,488**	**100.0**

Figure 20. ***Percentage distribution of primary hip arthroplasties by age group and type of arthroplasty. A) Total hip arthroplasty; B) Partial hip arthroplasty. Source RACat.***



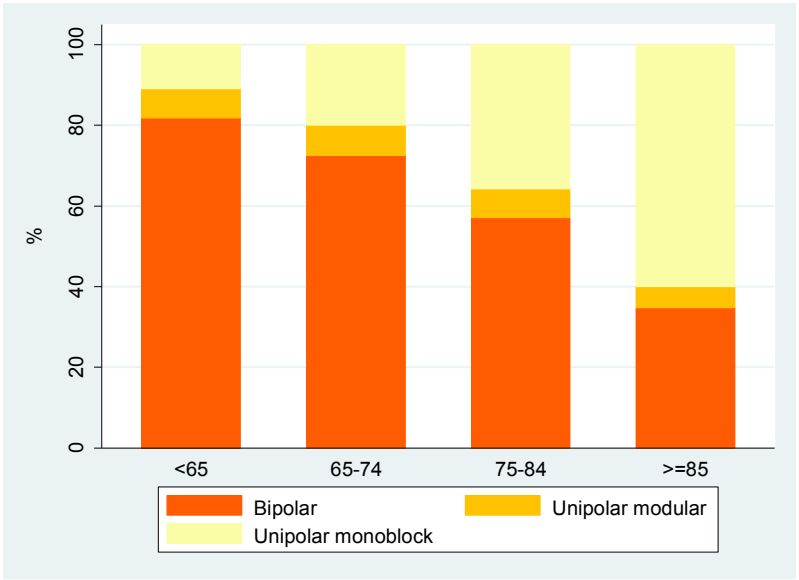


Table 37. *Number of primary total hip arthroplasties per fixation technique by time period. Source: RACat*

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Cemented	324	16.0	438	11.0	497	8.7	654	10.7	483	8.9	**2,396**	**10.3**
Cementless	1,065	52.7	2,408	60.4	3,798	66.1	4,049	66.1	3,809	70.1	**15,129**	**64.9**
Hybrid	571	28.3	990	24.8	1,214	21.1	1,243	20.3	997	18.4	**5,015**	**21.5**
Inverse hybrid	61	3.0	150	3.8	230	4.0	176	2.9	130	2.4	**747**	**3.2**
Not specified	0	0.0	0	0.0	4	0.1	6	0.1	15	0.3	**25**	**0.1**
Total	2,021	100.0	3,986	100.0	5,743	100.0	6,128	100.0	5,434	100.0	23,312	100.0

Table 38. *Number of primary partial hip arthroplasties per fixation technique by time period. Source: RACat*

	2005/2006		2007/2008		2009/2010		2011/2012		2013/2014		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Cemented	479	53.5	972	51.5	1,694	53.9	1,728	46.6	1,420	46.2	**6,293**	**49.5**
Cementless	416	46.5	914	48.5	1,452	46.2	1,983	53.4	1,654	53.8	**6,419**	**50.5**
Not specified	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	**1**	**0.0**
Total	895	100.0	1,886	100.0	3,146	100.0	3,711	100.0	3,075	100.0	12,713	100.0

Table 39. *Number of primary total hip arthroplasties per fixation technique and sex. Source RACat.*

	Men		Women		Total	
	n	%	n	%	n	%
Cemented	677	6.1	1,719	14.2	**2,396**	**10.3**
Cementless	8,165	73.1	6,964	57.4	**15,129**	**64.9**
Hybrid	1,805	16.2	3,210	26.5	**5,015**	**21.5**
Inverse hybrid	510	4.6	237	2.0	**747**	**3.2**
Not specified	20	0.2	5	0.0	**25**	**0.1**
Total	11,177	100.0	12,135	100.0	23,312	100.0

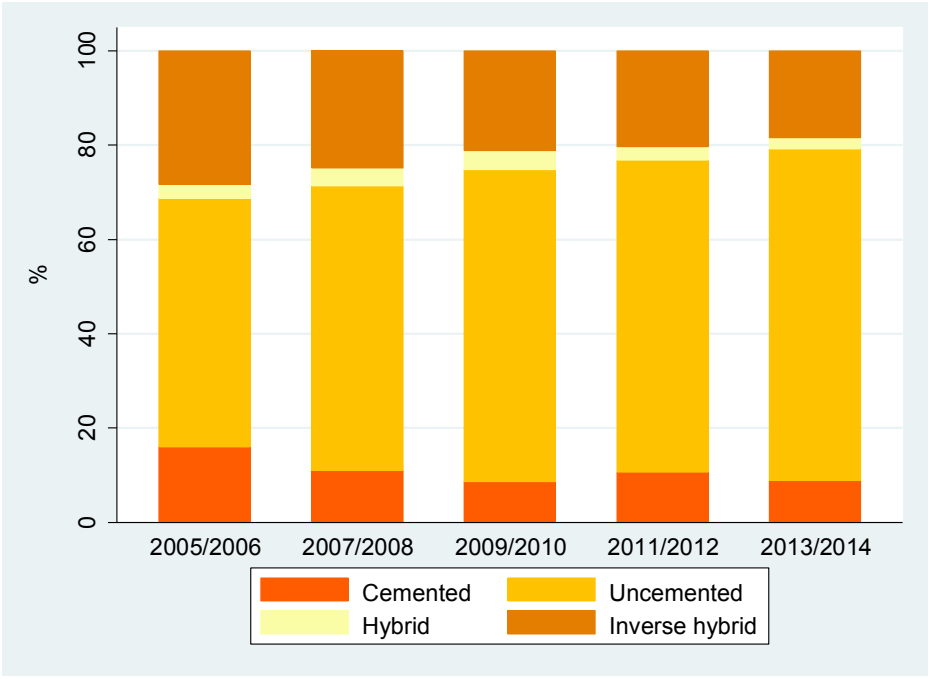
Table 40. *Number of primary partial hip arthroplasties per fixation technique and sex. Source RACat.*

	Men		Women		Total	
	n	%	n	%	n	%
Cemented	1,542	50.3	4,751	49.2	**6,293**	**49.5**
Cementless	1,521	49.6	4,898	50.8	**6,419**	**50.5**
Not specified	1	0.0	0	0.0	**1**	**0.0**
Total	3,064	100.0	9,649	100.0	12,713	100.0

Table 41. *Number of primary total hip arthroplasties per fixation technique by age group. Source RACat.*

	<65 years		65-74 years		75-84 years		>=85 years		Total	
	n	%	n	%	n	%	n	%	n	%
Cemented	99	1.3	363	5.0	1,611	21.7	323	35.2	**2,396**	**10.3**
Cementless	6,682	86.0	5,021	69.7	3,179	42.8	247	26.9	**15,129**	**64.9**
Hybrid	468	6.0	1,725	23.9	2,509	33.8	313	34.1	**5,015**	**21.5**
Inverse hybrid	500	6.4	92	1.3	121	1.6	34	3.7	**747**	**3.2**
Not specified	17	0.2	4	0.1	4	0.1	0	0.0	**25**	**0.1**
Total	7,766	100.0	7,205	100.0	7,424	100.0	917	100.0	23,312	100.0

Figure 21. ***Percentage distribution of the fixation technique of primary hip arthroplasties by time period. A) Total arthroplasties; B) Partial arthroplasties. Source RACat***



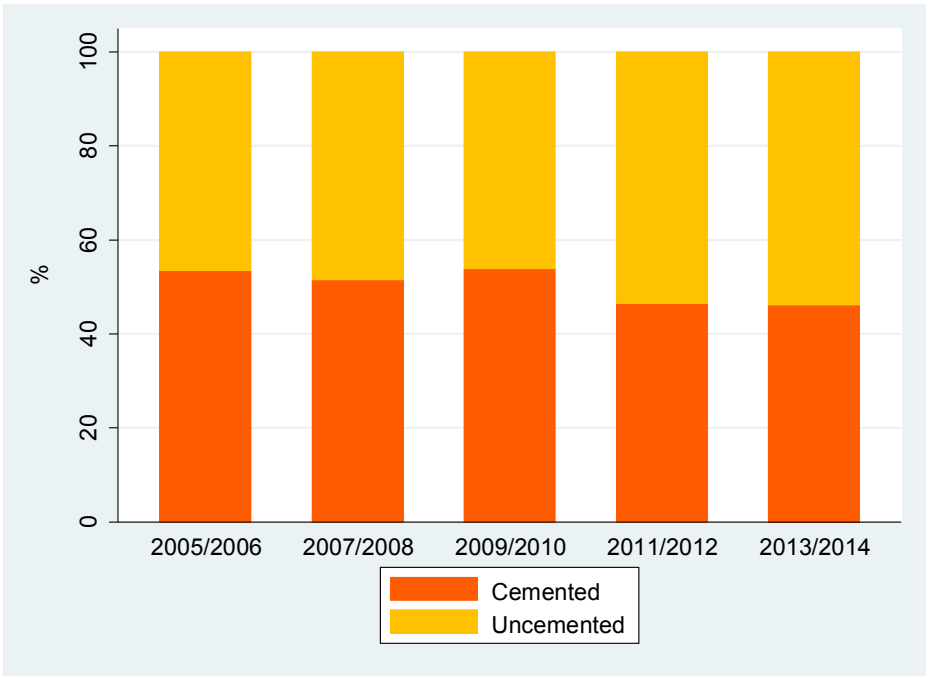


Table 42. ***Number of primary partial hip arthroplasties per fixation technique by age group. Source RACat***

	<65 years		65-74 years		75-84 years		>=85 years		Total	
	n	%	n	%	n	%	n	%	n	%
Cemented	148	77.1	560	74.2	3,041	59.9	2,544	38.1	**6,293**	**49.5**
Cementless	43	22.4	195	25.8	2,039	40.1	4,142	62.0	**6,419**	**50.5**
Not specified	1	0.5	0	0.0	0	0.0	0	0.0	**1**	**0.0**
Total	**192**	**100.0**	**755**	**100.0**	**5,080**	**100.0**	**6,686**	**100.0**	**12,713**	**100.0**

Table 43. ***Number of total conventional primary hip arthroplasties by type of friction device per age groups. Source RACat***

	<65 years		65-74 years		75-84 years		>=85 years		Total	
	n	%	n	%	n	%	n	%	n	%
Metal on Metal	544	8.0	238	3.4	241	3.3	56	6.2	**1,079**	**4.9**
Metal on Polyethylene	2,867	42.0	5,000	70.4	6,026	81.5	741	81.3	**14,634**	**65.8**
Ceramic on Ceramic	1,301	19.1	328	4.6	104	1.4	6	0.7	**1,739**	**7.8**
Ceramic on Polyethylene	1,321	19.4	861	12.1	413	5.6	24	2.6	**2,619**	**11.8**
Ceramic on Metal	102	1.5	35	0.5	7	0.1	2	0.2	**146**	**0.7**
Metal on Polycarbonate	1	0.01	3	0.04	2	0.03	0	0	**6**	**0.03**
Not specified	691	10.1	637	9.0	597	8.1	82	9.0	**2,007**	**9.0**
Total	**6,827**	**100**	**7,102**	**100**	**7,390**	**100**	**911**	**100**	**22,230**	**100**

Table 44. ***Distribution of friction device per head size among conventional hip arthroplasties. Source RACat***

	Metal on Metal		Metal on Polyeth-ylene		Ceramic on Ceramic		Ceramic on Polyethylene		Ceramic on Metal	
	n	%	n	%	n	%	n	%	n	%
<32 mm	467	43.3	10,639	72.7	409	23.5	1,773	68.1	**67**	**45.9**
32-36mm	227	21.0	3,892	26.6	1,234	71.0	830	31.9	**73**	**50.0**
>36 mm	385	35.7	99	0.7	96	5.5	1	0.04	**6**	**4.1**
Total	**1,079**	**100**	**14,630**	**100**	**1,739**	**100**	**2,604**	**100**	**146**	**100**

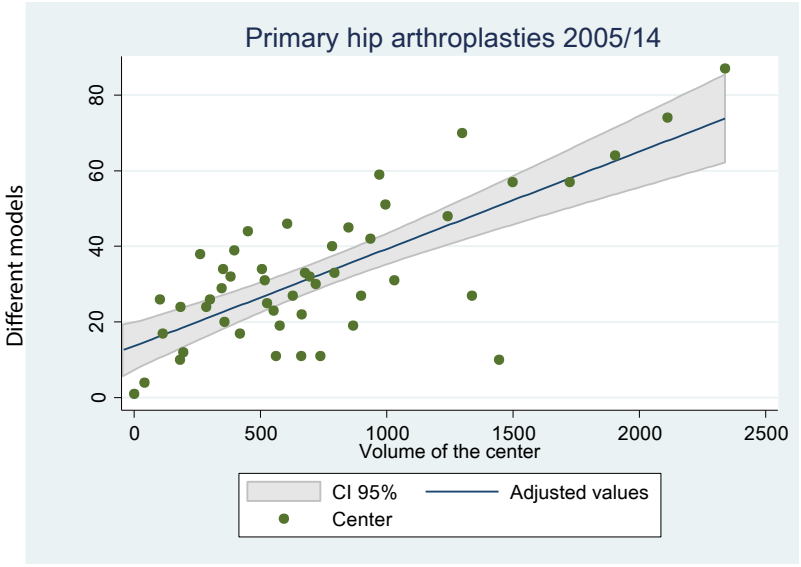
Information on the head size was not available in 2,032 cases, representing 9.1% of conventional hip arthroplasties.

5.4. Characteristics of implant models

In the period 2005-2014, a total of 1,114 models of stem-socket combinations (counting separately the cemented and uncemented models. Ex. Evoris cim and Evoris) were identified. In primary total hip arthroplasties, the number of acetabular models used by the hospitals ranged from 1 to 34, with an average of 16 per hospital. As for stem models, the number ranged from 1 to 33 with an average of 15 models used per hospital. As observed for knee arthroplasties, the number of implanted models grows in proportion to an increase in the volume of arthroplasties per centre (Figure 22).

Table 45 shows the five most frequent models in primary hip arthroplasty per type of arthroplasty and period. In the case of total hip arthroplasties, each model is presented as the combination of stem and socket component, and in the partial hip arthroplasties the stem model and the manufacturer are specified.

Figure 22. ***Number of different prostheses models in relation to the volume of primary hip arthroplasties for each centre sent to the RACat in the 2013-2014 period. Source: RACat***



Both total and partial arthroplasties were considered.

Table 45. ***Five most frequent models in primary hip arthroplasty per type of arthroplasty and period. Source: RACat***

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
Double mobility (stem/cup)														
						FURLONG/ NOVAE E	2	100.0	FURLONG/ POLARCUP	3	21.4	SHINE-C cim/ DMX	8	53.3
									A-ACUTA S/ POLARCUP	2	14.3	FURLONG/ DOUBLE MOBILITY	2	13.3
									AUTOBLOQUEANTE cim/NOVAE E	1	7.1	POLARSTEM/ POLARCUP	2	13.3
									EXETER cim/ NOVAE E	1	7.1	SHINE-C cim/ DUAL cim	2	13.3
									FURLONG/ NOVAE E	1	7.1	FURLONG/ DOUBLE MOBILITY	1	6.7
Resurfacing (head/cup)														
ASR/ASR	13	56.5	ASR/ASR	37	29.8	RECAP/RECAP	63	26.9	RECAP/RECAP	33	27.3	CONSERVE PLUS/ CONSERVE	23	50.0
CONSERVE PLUS/ CONSERVE	5	21.7	RECAP/RECAP	33	26.6	CONSERVE PLUS/ CONSERVE	47	20.1	DUROM/ MMC	25	20.7	ICON TM/ICON TM	13	28.3
BHR/BHR	4	17.4	CONSERVE PLUS/ CONSERVE	18	14.5	CORMET/ CORMET	45	19.2	CONSERVE PLUS/ CONSERVE	23	19.0	RECAP/RECAP	7	15.2
RECAP/RECAP	1	4.4	ICON TM/ICON TM	16	12.9	ADEPT/ADEPT	22	9.4	CORMET/CORMET	18	14.9	CORMET/CORMET	2	4.4
			ADEPT/ ADEPT	8	6.5	BHR/BHR	15	6.4	ICON TM/ICON TM	13	10.7	BHR/BHR	1	2.2
Conventional (stem/cup)														
VERSYS/TRILOGY	210	10.5	VERSYS cim/ TRILOGY	358	9.3	FURLONG/CSF PLUS	305	5.7	FURLONG/CSF PLUS	450	7.7	FURLONG/CSF PLUS	410	7.9
VERSYS cim/ TRILOGY	158	7.9	VERSYS/ TRILOGY	356	9.3	VERSYS cim/ TRILOGY	277	5.2	UNITED U2/ U2	339	5.8	CORAIL/PINNACLE	276	5.3

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
FURLONG/FURLONG	136	6.8	UNITED U2/ UNITED U2	198	5.2	UNITED U2/ UNITED U2	270	5.0	VERSYS cim/ TRILOGY	246	4.2	VERSYS cim/TRILOGY	213	4.1
UNITED U2/ UNITED U2	134	6.7	SYMAX/ TRIDENT	152	4.0	VERSYS/TRILOGY	244	4.5	CORAIL/PINNACLE	235	4.0	NOVATION ELEMENT/ NOVATION CROWN	199	3.8
ECO cim/EXPANSYS	92	4.6	CORAIL/PINNACLE	110	2.9	CORAIL/ PINNACLE	236	4.4	EXETER cim/ CONTEMPORARY cim	195	3.3	UNITED U2/UNITED U2	164	3.2
Short stem (stem/cup)														
MAYO/TRILOGY	1	50.0	PROXIMA/ASR	18	66.7	PROXIMA/ PINNACLE	47	37.6	PROXIMA/PINNACLE	51	33.6	ACCOLADE II/TRIDENT	45	22.8
PROXIMA/ASR	1	50.0	PROXIMA/ PINNACLE	7	25.9	C.F.P. LINK/ T.O.P. LINK	27	21.6	TAPERLOC MICROPLASTY/ EXCEED ABT	30	19.7	TAPERLOC MICROPLASTY/ BIHAPRO	23	11.7
			PROXIMA/ REFLECTION SP3	1	3.7	C.F.P. LINK/ CFP-BETA CUP	25	20.0	MINIHIP/ TRABECULAR METAL	24	15.8	C.F.P. LINK/COMBICUP	21	10.7
			PROXIMA/TRIDENT	1	3.7	PROXIMA/ASR	11	8.8	C.F.P. LINK/ T.O.P. LINK	15	9.9	FURLONG EVOLUTION/CSF PLUS	19	9.6
						TAPERLOC MICROPLASTY/ EXCEED ABT	3	2.4	C.F.P. LINK/ COMBICUP	8	5.3	PROFEMUR PRESERVE/ PROCOTYL	13	6.6
Bipolar (stem/shell)														
AUTOBLOQUEANTE cim/BIARTICULAR	57	16.8	AUTOBLOQUEANTE cim/BIARTICULAR	268	32.8	AUTOBLOQUEANTE cim/BIARTICULAR	354	21.9	AUTOBLOQUEANTE cim/BIARTICULAR	349	20.9	AUTOBLOQUEANTE cim/ BIARTICULAR	324	21.7
MULLER cim/UHR BIPOLAR	46	13.6	MAINSTREAM MULLER cim/ CAPTIVE	120	14.7	VERSYS cim/ MULTIPOLAR	138	8.5	KAREY cim/ MOONSTOONE	157	9.4	KAREY cim/ MOONSTOONE	177	11.9
MAINSTREAM MULLER cim/ CAPTIVE	45	13.3	VERSYS cim/ MULTIPOLAR	89	10.9	EXETER cim/ UHR BIPOLAR	107	6.6	VERSYS cim/ MULTIPOLAR	156	9.4	VERSYS cim/ MULTIPOLAR	129	8.7
ECO cim/CAPTIVE	35	10.3	EXETER cim/ UHR BIPOLAR	63	7.7	KAREY cim/ BIARTICULAR	85	5.3	SHINE-C cim/ BIARTICULAR	117	7.0	SHINE-C cim/ BIARTICULAR	124	8.3
VERSYS cim/ MULTIPOLAR	35	10.3	ECO cim/CAPTIVE	60	7.3	PMB cim/BIPOLAR	85	5.3	EXETER cim/UHR BIPOLAR	77	4.6	EXETER cim/ UHR BIPOLAR	107	7.2

2005/2006			2007/2008			2009/2010			2011/2012			2013/2014		
Model	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**	**Model**	**n**	**%**
Unipolar modular (stem/head)														
ECO cim/HEMIHEAD	60	62.5	ECO cim/HEMIHEAD	88	66.7	AUTOBLQUEANTE cim/ENDOCEFÁLICA	75	32.5	AUTOBLOQUEANTE cim/ENDOCEFÁLICA	81	39.1	TWINSYS cim/ HEMIHEAD	34	29.8
ECO cim/S30	36	37.5	FULLFIX cim/ HEMIHEAD	43	32.6	CCM cim/ HEMIHEAD	56	24.2	TWINSYS cim/ HEMIHEAD	54	26.1	TAPERLOC cim/ BIOMET Head	30	26.3
			MAINSTREAM MULLER cim/ BIOMET Head	1	0.8	FULLFIX cim/HEMI-HEAD	45	19.5	CCM cim/HEMIHEAD	44	21.3	AUTOBLOQUEANTE cim/ENDOCEFÁLICA	22	19.3
						CEMIRA cim/ HEMIHEAD	27	11.7	CEMIRA cim/ HEMIHEAD	25	12.1	TAPERLOC/ BIOMET Head	18	15.8
						ECO cim/ BIOMET Head	21	9.1	WAGNER SL/ HEMIHEAD	2	1.0	MULLER cim/ ENDOCEFÁLICA	8	7.0
Unipolar monoblock (stem/manufacturer)														
AUSTIN MOORE/ SURGIVAL C.O., S.A.	203	44.1	AUSTIN MOORE/ SURGIVAL C.O., S.A.	392	41.9	AUSTIN MOORE/ SURGIVAL C.O., S.A.	595	45.8	AUSTIN MOORE/ SURGIVAL C.O., S.A.	1,000	54.5	AUSTIN MOORE/ SURGIVAL C.O., S.A.	899	61.2
AUSTIN MOORE/ STRIKER IBERIA, SL	111	24.1	AUSTIN MOORE/ STRYKER IBERIA, SL	357	38.1	AUSTIN MOORE/ STRYKER IBERIA, SL.	518	39.9	AUSTIN MOORE/ STRYKER IBERIA, SL.	648	35.3	AUSTIN MOORE/ STRYKER IBERIA, SL.	450	30.6
THOMPSON cim/ SURGIVAL C.O., S.A.	76	16.5	THOMPSON cim/ SURGIVAL C.O., S.A.	84	9.0	THOMPSON/ STRYKER IBERIA, SL.	89	6.9	THOMPSON/ STRYKER IBERIA, SL.	98	5.3	THOMPSON/ STRYKER IBERIA, SL.	79	5.4
AUSTIN MOORE/ BIOMET	46	10.0	AUSTIN MOORE/ TRAIBER, S.L.	36	3.9	THOMPSON cim/ SURGIVAL C.O., S.A.	80	6.2	THOMPSON cim/ SURGIVAL C.O., S.A.	78	4.3	THOMPSON cim/ SURGIVAL C.O., S.A.	29	2.0
AUSTIN MOORE/ TRAIBER, S.L.	24	5.2	AUSTIN MOORE/ BIOMET	35	3.7	THOMPSON cim/ STRYKER IBERIA, SL.	7	0.5	THOMPSON cim/ STRYKER IBERIA, SL.	6	0.3	THOMPSON cim/ BIOMET	11	0.8

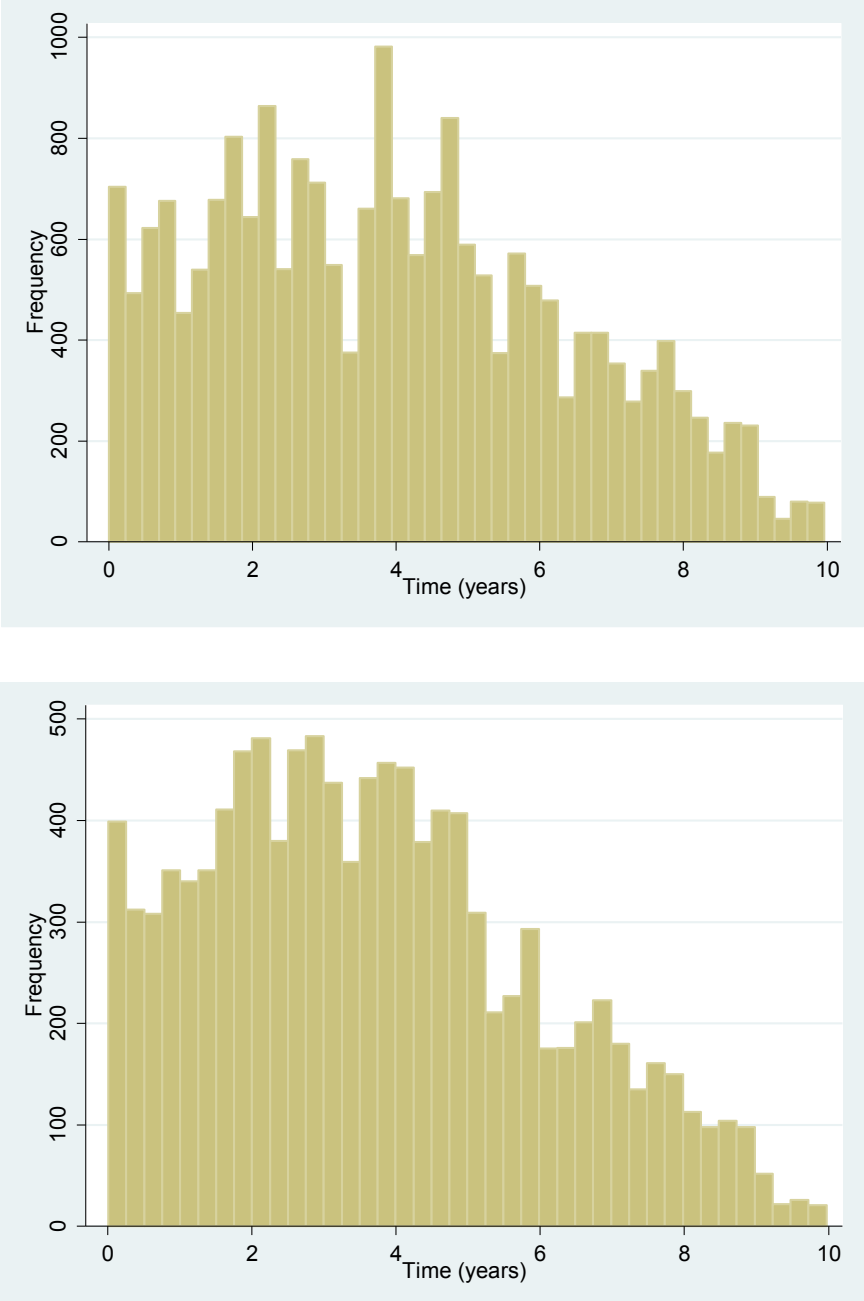
Percentages were calculated for each type of prosthesis out of total of prostheses used in each type of arthroplasty. Only the values of the 5 most common models are shown in the table, which explains that for some types of arthroplasties percentages do not add up to 100.

5.5. Implant survival in hip arthroplasties

Follow-up description

The median length of follow-up from the date of primary arthroplasty until the revision surgery or censorship was 3.93 years (SD: 2.42) and 3.71 years (SD: 2.28) for total and partial hip arthroplasties, respectively. Figure 23 shows the distribution of follow-up time for patients who underwent total and partial hip arthroplasty.

Figure 23. ***Distribution of the follow-up time of patients undergoing a hip arthroplasty. A) Total arthroplasty; B) Partial arthroplasty. Source: RACat***



Cumulative revision rate

The estimated cumulative revision rate after a primary total and partial hip arthroplasty (with no adjustment) is shown in Table 46 and Table 47. For total hip arthroplasties, the cumulative revision rate at 1- year was 1.29%, rising to 2.99% at 5-year and 4.57% at 9-years after the primary surgery. For partial hip arthroplasties, the cumulative revision rates were 1.23%, 2.11%, and 2.38% at 1-, 5- and 9-years after the primary surgery, respectively.

Risk of revision both for patients undergoing total and partial hip arthroplasty was adjusted by sex, age, and comorbidities. As observed for knee arthroplasties, a higher risk of revision was observed in groups of younger patients. The Cox model fitted for total hip arthroplasties revealed a significant statistical risk of revision for patients under 65 years, patients between 65-75 years, and patients between 75-85 years compared to those aged 85 years or over (HR=2.87 (CI 95%: 1.47-5.61); HR=2.38 (CI 95%: 1.22-4.65); HR= 1.96 (CI 95%: 1.00-3.84); data not shown). A similar trend was observed for partial hip arthroplasties for patients aged 65-75 years and 75-85 years (HR=2.81 (CI 95%: 1.78-4.45; HR=1.63 (CI 95%: 1.21-2.20); data not shown).

The cumulative revision rate by fixation technique (without adjustment) for total hip arthroplasties revealed relatively similar revision rates at different follow-up times. Cementless prostheses were those with the highest revision rates at 5- and 9-year of follow-up (3.11% and 5.05%, respectively) (Table 48, Figure 24). For partial hip arthroplasties, the cumulative revision rate for cemented prosthesis was 1.21% at 1-year follow up, and rose to 1.78% and 1.92% at 3- and 5-year follow-up. For cementless prostheses the figures were 1.18%, 1.86% and 2.32% at 1-, 3-, and 5-year of follow-up (Table 49). Risk of revision both for total and partial hip arthroplasties adjusted by sex, age and comorbidities and fixation technique revealed no differences in the risk of revision, age being the only factor associated with revision risk (data not shown).

Table 50 shows the cumulative probabilities of revision per friction device for total hip arthroplasties. Metal on metal prostheses showed revision rates of 1.98%, 3.61% and 5.49% at 1-, 3- and 5- years of follow-up, whereas metal-polyethylene prosthesis presented slightly better outcomes: 1.84%, 2.62% and 3.38%, respectively. The Cox model considering friction device (Metal on Polyethylene, Metal on Metal, Ceramic on Ceramic and Ceramic on Polyethylene) and adjusted by age, sex and comorbidities revealed an increased revision rate for Metal on Metal prosthesis in comparison to Metal on Polyethylene prosthesis (HR=1.43 CI 95%: 1.06-1.93; data not shown).

We estimated the cumulative incidence of revision considering death as a competitive event, both for partial and total hip arthroplasties. Figure 25 shows two functions: one with the cumulative risk of revision adjusted by age, sex, comorbidity and patient death probability, and the other adjusted by the same variables without considering the competitive risk of death. For total hip arthroplasties, both curves are quite similar, the cumulative incidence function without adjustment by competitive risk of death slowly growing apart from the other curve. The cumulative incidence of revision, adjusted by age, sex, and comorbidity at 5 years was 3.20% and considering competitive risk of death, 3.15%. However, for partial knee arthroplasties differences are greater, especially after 2-3 years of follow-up. The cumulative incidence of revision, adjusted by age, sex, and comorbidity at 5 years was 2.36% and considering competitive risk of death 2.05%.

Table 46. ***Estimated cumulative revision rate after a primary total hip arthroplasty. Source: RACat-MBDSHD-RCA***

Time	Primary	Revisions	Cumulative Revision Rate (%)	CI 95%	
30 days	20,654	79	0.38	0.30	0.47
90 days	20,106	97	0.85	0.73	0.99
1 year	18,253	85	1.29	1.14	1.45
3 years	12,378	142	2.18	1.98	2.40
5 years	6,600	80	2.99	2.72	3.28
7 years	2,775	42	3.88	3.51	4.28
9 years	306	12	4.57	4.03	5.17

CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register

Table 47. ***Estimated cumulative revision rate after a primary partial hip arthroplasty. Source: RACat- MBD-SHD-RCA***

Time	Primary	Revisions	Cumulative Probability of revision	CI 95%	
30 days	10,949	46	0.42	0.31	0.56
90 days	10,684	57	0.94	0.78	1.14
1 year	9,717	30	1.23	1.04	1.46
3 years	6,319	51	1.82	1.57	2.10
5 years	2,969	15	2.11	1.83	2.43
7 years	1,154	1	2.18	1.87	2.54
9 years	*114*	*1*	*2.38*	*1.92*	*2.95*

CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register
Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Table 48. ***Estimated cumulative revision rate after a primary total hip arthroplasty by fixation technique. Source: RACat- MBDSHD-RCA***

Time	Primary	Revisions	Cumulative Revision Rate (%)	CI 95%	
Cemented					
30 days	2,049	12	0.58	0.33	1,02
90 days	2,000	12	1.17	0.78	1.74
1 year	1,870	6	1.47	1.03	2.10
3 years	1,258	11	2.12	1.56	2.87
5 years	730	6	2.69	2.00	3.60
7 years	380	3	3.25	2.38	4.44
9 years	66	0	.	.	.
Cementless					
30 days	13,563	45	0.33	0.25	0.44
90 days	13,167	67	0.83	0.69	0.99
1 year	11,826	56	1.27	1.09	1.47
3 years	7,894	89	2.12	1.88	2.40
5 years	4,039	62	3.11	2.77	3.49
7 years	1,553	30	4.17	3.68	4.73
9 years	*158*	*8*	*5.05*	*4.28*	*5.95*
Hybrid					
30 days	4,387	19	0.43	0.27	0.67
90 days	4,292	17	0.82	0.59	1.13
1 year	3,953	20	1.30	1.00	1.68
3 years	2,775	38	2.42	1.98	2.96
5 years	1,583	9	2.85	2.34	3.47
7 years	770	9	3.60	2.92	4.43
9 years	71	4	.	.	.
Inverse Hybrid					
30 days	636	3	0.47	0.15	1.45
90 days	630	1	0.63	0.24	1.66
1 year	593	3	1.10	0.53	2.30
3 years	449	4	1.86	1.03	3.34
5 years	250	3	2.69	1.56	4.60
7 years	75	0	.	.	.
9 years	13	0	.	.	.

CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register
Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Table 49. ***Estimated cumulative revision rate after a primary partial hip arthroplasty by fixation technique. Source: RACat***

Time	Primary	Revision	Cumulative Revision Rate (%)	IC95%	
Cemented					
30 days	5,420	24	0.44	0.30	0.66
90 days	5,286	32	1.03	0.79	1.34
1 year	4,839	13	1.28	1.01	1.62
3 years	3,306	22	1.78	1.45	2.18
5 years	1,531	4	1.92	1.57	2.36
7 years	579	1	2.06	1.64	2.60
9 years	67	1	.	.	.
Cementless					
30 days	5,527	22	0.40	0.26	0.60
90 days	5,396	25	0.85	0.64	1.13
1 year	4,877	17	1.18	0.92	1.50
3 years	3,013	29	1.86	1.52	2.28
5 years	1,438	11	2.32	1.90	2.84
7 years	576	0	2.32	1.90	2.84
9 years	48	0	.	.	.

CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register
Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

Figure 24. ***Cumulative risk of revision after a total hip arthroplasty by fixation technique. Source: RACat-MBDSHD-RCA***

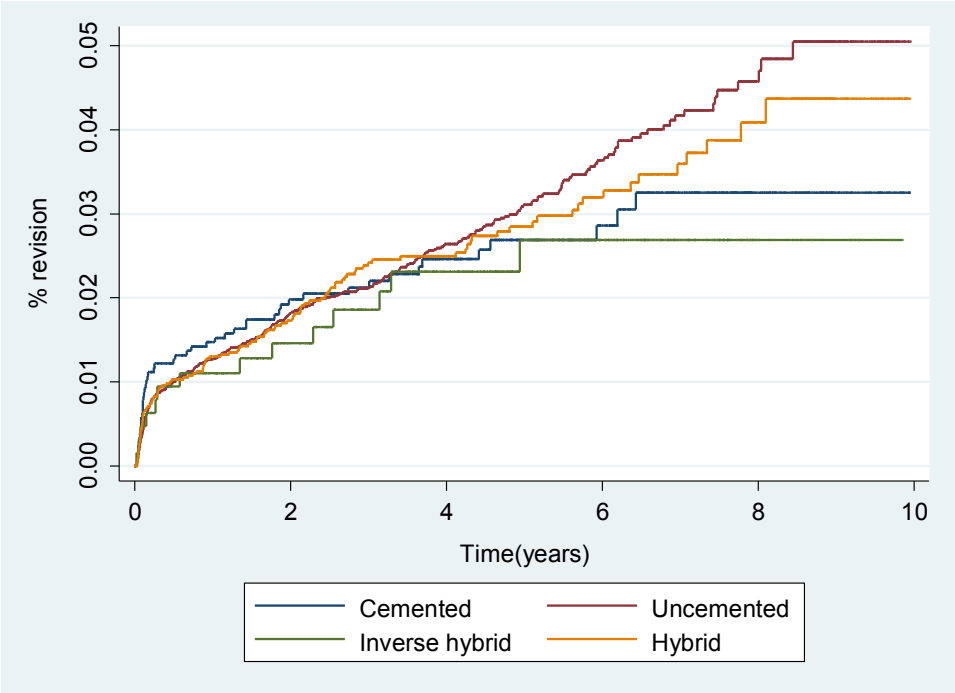


Table 50. ***Estimated cumulative revision rate after a primary total conventional hip arthroplasty per friction device. Source: RACat***

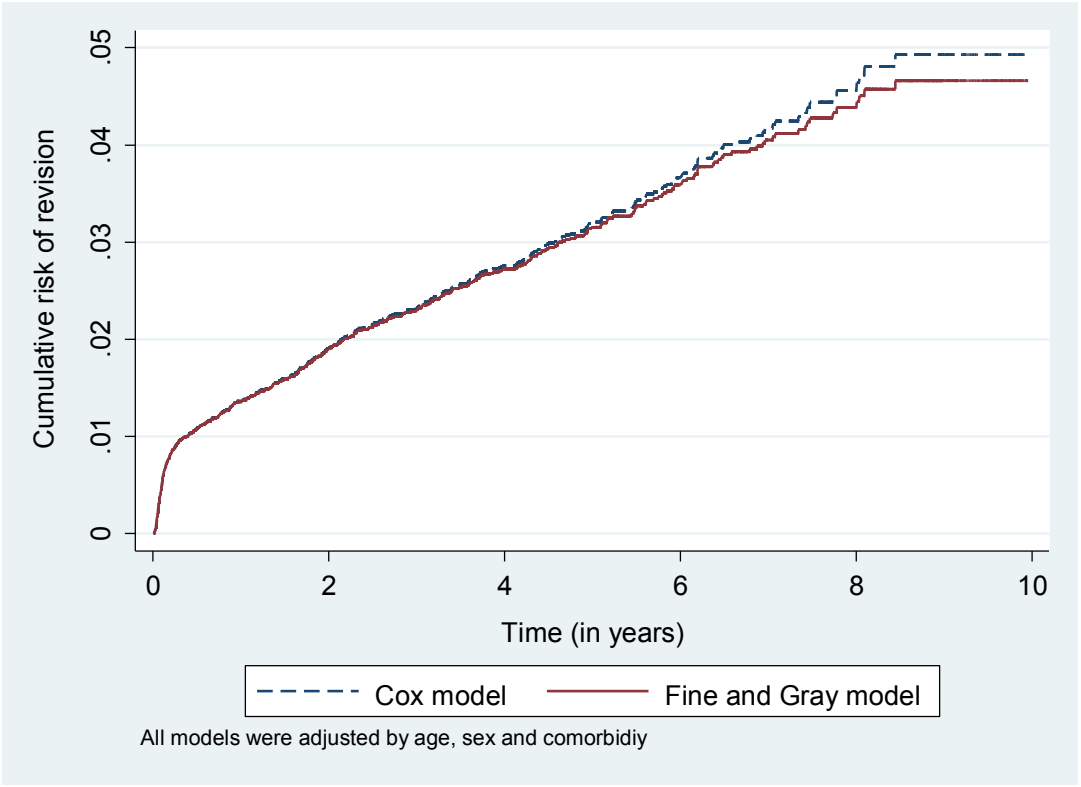
Time	Primary	Revision	Cumulative Revision Rate (%)	CI 95%	
Metal on Metal					
30 days	970	6	0.61	0.27	1.35
90 days	936	9	1.54	0.93	2.54
1 year	864	4	1.98	1.27	3.09
3 years	687	13	3.61	2.56	5.08
5 years	420	11	5.49	4.06	7.4
7 years	*134*	*6*	*7.42*	*5.48*	*10.01*
9 years	*12*	*1*			
Metal on polyethylene					
30 days	13448	113	0.83	0.69	1
90 days	13139	83	1.45	1.26	1.66
1 year	12111	50	1.84	1.62	2.08
3 years	8489	85	2.62	2.35	2.92
5 years	4761	53	3.38	3.05	3.74
7 years	2109	30	4.25	3.8	4.74
9 years	*219*	*7*	*4.72*	*4.16*	*5.35*
Ceramic on Polyethylene					
30 days	2413	7	0.29	0.14	0.6
90 days	2343	2	0.37	0.19	0.71
1 year	2096	13	0.95	0.63	1.45
3 years	1401	18	1.94	1.42	2.64
5 years	760	7	2.58	1.91	3.47
7 years	318	3	3.14	2.28	4.32
9 years	52	4			
Ceramic on Ceramic					
30 days	1664	5	0.3	0.12	0.71
90 days	1617	3	0.48	0.24	0.96
1 year	1456	8	0.99	0.61	1.62
3 years	763	13	2.06	1.42	2.97
5 years	282	6	3.19	2.19	4.64
7 years	*112*	*3*	*4.78*	*3.03*	*7.51*
9 years	26	0			

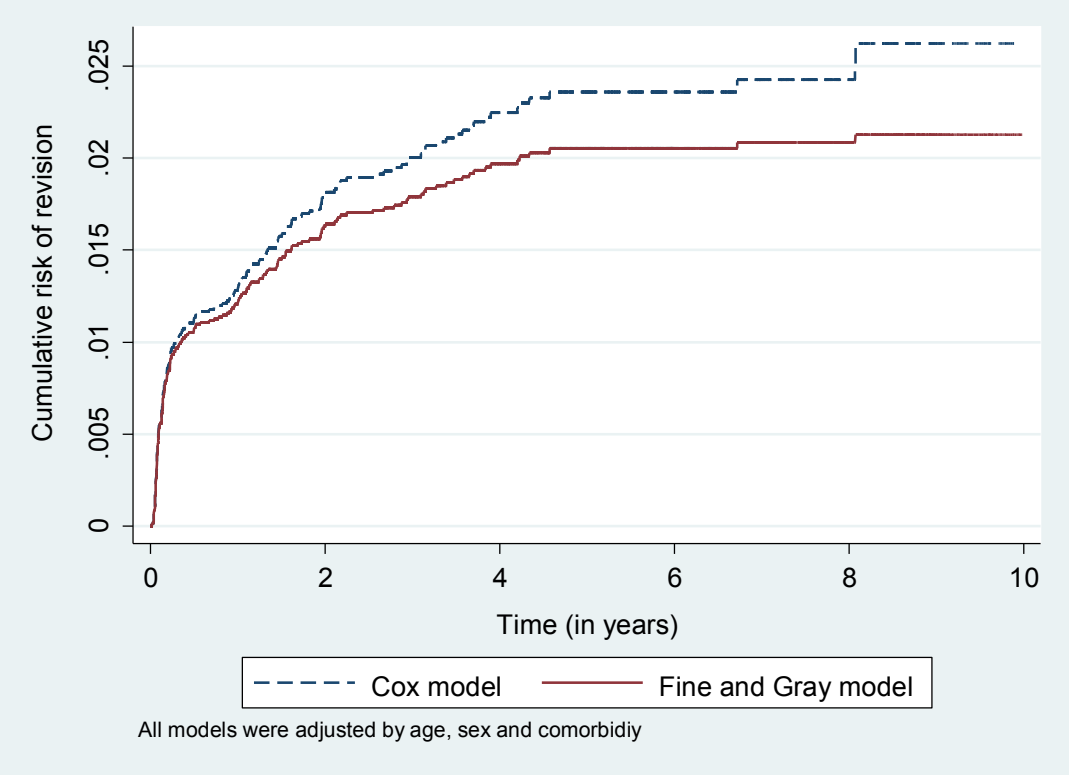
CI 95%: 95% confidence interval. RACat: Catalan Arthroplasty Register

Estimates in *italics* indicate that fewer of 250 remain at risk of revision at the time shown. Blank cells indicate that the number at risk at the time shown is fewer than 100 cases. In that case, estimates were not calculated since they are very unreliable.

The number of patients at risk for the other fixation categories was <100; the estimates were not calculated since they were very unreliable.

Figure 25. ***Cumulative incidence of revision after a partial hip arthroplasty adjusted by competitive risk of death, age and sex. A) Total hip arthroplasty; B) Partial hip arthroplasty. Source RACat-RCA***





6. Discussion

The results presented in this report provide an overview of the continued improvement of the Catalan Arthroplasty Register (RACat) regarding the volume and quality of the data. We also report the characteristics of patients undergoing hip and knee arthroplasty, as well as implant characteristics and prosthesis survival considering the procedures carried out between 2005 and 2014 in Catalonia.

6.1. Quality of the data: volume of interventions and completeness

Following a steady rise in the number of hip and knee cases reported to the RACat as of 2005, the data demonstrates a decrease between 2010 and 2011. This decrease was linked to a reorganisation of hospital care carried out in Catalonia that year, given that once this had finished in 2012, the number of interventions being reported to the register started to gradually rise again.

However, the increase in the number of arthroplasties in the last year was not reflected in the data sent to the RACat. This was due to the fact that, at the end of 2013, hospitals had to temporarily stop their data notifications in order to adapt their IT systems to the technical requirements of the Catalan Health Service (CHS), which included a new web services communication process. This is the reason why RACat completeness values also decreased during the latter-period (2013-2014). Nevertheless, they can be expected to improve as a result of the satisfactory resolution of this circumstance.

Even with the improvement of completeness and the quality of the data, further strategies must be designed to allow even greater improvement to continue. The participation of private centres will be essential in order to have a complete picture of the healthcare assistance activity in Catalonia.

6.2. Description of patients and the healthcare process

Confirming trends observed in previous reports and in other countries[3,4,10-12], the current results show that both knee and hip arthroplasties were more frequently preformed among women than among men, osteoarthritis being by far the most prevalent reason for intervention in total hip and both total and partial knee arthroplasties. Meanwhile, mechanical complications of orthopaedic devices were the main reason for revision, a situation that had already been observed in other European registers, which reported aseptic loosening as the main cause for revision[3]. In the RACat, aseptic loosening was analysed together with other diagnoses such as dislocation and contact surface wear, under the concept of mechanical complications.

Results pointed out that the majority of patients undergoing hip and knee arthroplasties presented one or more comorbidities. This may be related to increased life expectancy and to improvements in surgical techniques, which have made it possible to operate on older patients, who tend to have a higher number of comorbidities. However, some specific comorbidities such as obesity, renal failure and neurological disorders, have been highlighted as obstacles in the

recovery process, since these patients will be less likely to increase their physical activity after elective surgery[13].

Regarding the type of discharge from hospital, the most common destination was home. Although this appears to be better in terms of early recovery[14], patient satisfaction and healthcare costs, there is no clear evidence regarding the impact it might have on the long-term recovery process[15]. For this reason, it may be interesting for future studies to look at potential readmissions of patients per their discharge type, in order to obtain more evidence on the healthcare quality of this practice after an arthroplasty.

6.3. Characteristics of primary arthroplasties and implant models

Our findings revealed significant variability in the number of prosthesis models used depending on the hospital, both for knee and hip arthroplasties. Some studies suggested that using a high number of models could be a risk factor for revision[16]. Based on the results of the Swedish register, this group recommends limiting the number of models in use, with expectations of reducing the risk of revision. This measure, if confirmed, could be of interest for Catalonia, given the wide variability observed in our hospitals. Further analyses aimed at exploring the specific results of implant models would facilitate the decision-making process for professionals based on reliable clinical evidence. Some initiatives, such as the Orthopaedic Data Evaluation Panel (ODEP)[17] in the UK, or the Dutch Hip Task Force (DHTF)[18] in The Netherlands, provide on-going assessment of hip and knee implants presenting a benchmark rating for implant survival.

In accordance with trends observed in the latter period, the most common knee procedure was total knee arthroplasty. Although the number of partial arthroplasties has increased slightly during the most recent periods, their impact on overall knee procedures remains low. In the case of primary hip arthroplasties, the number of partial procedures has increased. For this kind of surgery, we observed a decreasing trend over time on the use of unipolar monoblock and an increase of bipolar prosthesis. This pattern was also observed in Australia[19] but contrasts with trends reported in Sweden[11].

Regarding the type of fixation, RACat recorded an increase in the volume of primary cemented knee arthroplasties, confirming trends observed in latter periods. On the contrary, most of total hip arthroplasties were cementless, this type of fixation showing an increasing trend over time, especially among young patients. This pattern is consistent with trends reported in other countries like Norway[20], Sweden[11], New Zealand[21], and the United Kingdom[22]. Likewise, the use of metal on metal as bearing surface has decreased over time, whereas metal-polyethylene is increasingly used.

6.4. Implant survival

In general, both knee and hip arthroplasties presented good implant survival, both in the short, medium, and long-term. Total knee arthroplasties showed better survival outcomes than partial replacements. In particular, tour finding show a 9-year revision rate less than 4% for cemented and hybrid prosthesis, this data being in accordance with that reported in other countries[22]. Unicompartmental replacements showed worse survival results compared to total knee replacements with the chance of revision at each estimation time point being around twice that of a

total knee replacement. It has to be considered that this surgery has different indications than total knee arthroplasty, being more commonly performed among younger patients. This may be related to milder disease in these patients, or the desire to delay a total knee replacement for as long as possible. Moreover, younger patients may also be more active and are more likely to present better health conditions, which puts more strain on their implants and allows reoperation if a complication or failed prosthesis occurrs.

Following trends observed in previous reports, partial hip arthroplasties presented better survival outcomes than total hip procedures. Again, differences in patient's age may explain the different results, given that partial arthroplasties are more commonly performed in older patients, as an indication of femoral neck fracture.

As expected, metal on metal implants showed significantly higher revision rates in comparison to other friction devices, confirming in our setting the unsatisfactory results of these bearing devices in the medium- and long-term reported in the literature[23]. This situation calls for close surveillance of patients with this kind of prosthesis and for monitoring the degree of accomplishment of recommendations issued by public bodies. In parallel, current data points out that ceramic–metal implants presented the lowest failure rates, followed by metal-polyethylene implants.

6.5. Strengths and weaknesses

After 10 years of implementation of the RACat, current data provides us with an overall picture of the performance of hip and knee arthroplasties in Catalonia as well as robust estimators on implant utilization and survival outcomes. However, we would like to pint out certain limitations that should be taken into consideration when interpreting the results presented herein. Firstly, the volume of cases in some subgroups remains low, especially in the survival analyses. This situation hampers the calculation of risk of revision in the medium- and long-term. As a result, long-term survival outcomes for some figures should be interpreted with caution.

Secondly, we wish to point out the high number of cases in which the type of fixation was not specified, most notably in the earlier years of the register. During this period, the emphasis was on the implementation of the register, without as much emphasis being placed on the quality of the data as there is now. It is hoped that in coming years the percentage of cases not reported to the RACat will gradually decrease, as has been the trend to date. Finally, as we have already mentioned above, the information on cause for revision was obtained by merging our database with the MBDSHD. As pointed out, there are some deficiencies in the MBDSHD coding that hamper the level of detail of this variable. We do believe that with the implementation of the surgical form, we will overcome this limitation, given that this form will allow us to collect more accurate information regarding this variable along with other clinical information.

Despite the limitations mentioned above and the difficulty and high cost involved in implementing and maintaining a register of this kind, we can assert that the RACat has consolidated itself as a powerful tool for analysing the medium- and long-term effectiveness of hip and knee arthroplasties, for studying the variability of clinical practice, and for post-market monitoring.

7. Final Remarks and Next Steps

7.1. Latest achievements

Year after year we stress our commitment to improve the quality of the Register and to publicize the results and the potential of this tool for managers, surgeons and healthcare professionals. In this line, we would like to highlight some of the activities and products that have been released over the last year.

Commemoration of the 10th anniversary of the RACat. A multidisciplinary, informative session was organised in conjunction with the Catalan Society of Orthopaedic Surgery and Traumatology (SCCOT). Experts from different fields of health care, management, research, industry, and administration were invited, with the aim of pooling knowledge and perspectives on the scope and implications of the RACat. These different points of view, along with the patient's vision, were recorded in an educational video, which is available on our website: http://aquas.gencat.cat/ca/projectes/mes_projectes/qualitat_atencio_sanitaria/racat/

Atlas of Variation of Knee and Hip Arthroplasties in Catalonia. As part of a wider project lead by the Agency for Health Quality and Assessment (AQuAS), Atlases of Variations in Knee and Hip Arthroplasties in Catalonia were presented using an interactive format. This new format, which uses the InstantAtlas Dynamic Report Platform, allows us to view data from different basic healthcare areas in Catalonia and to benchmark the performance of both surgeries over different time periods. These arealso available on our website: http://aquas.gencat.cat/ca/projectes/atles-de-variacions-i-de-qualitat-del-siscat/atles_variacions/atles_finalitzats/atles_genoll/atles_digital_artroplasties_genoll_maluc/

Research. The RACat is also involved in several research projects lead by clinicians, epidemiologists, and healthcare professionals, which explore different issues related to arthroplasties performance and its impact on the healthcare system.

7.2. Next steps

For the upcoming years, we face new challenges that we are sure will contribute to improving the quality of the register and will promote the visualization and utilization of the RACat.

Implementation of the surgical form. The inclusion of variables from the surgical form will substantially increase the information recorded in the register (mainly clinical information), enriching the current dataset and enhancing the possibility to refine some analyses. Although some hospitals are currently reporting the variables of this form, there is still room for improvement in its complete implementation in Catalonia.

Data from private centres. The current scope of the register includes hospitals run by the Integrated Healthcare System of Public Healthcare Network of Catalonia (SISCAT). Widening the

scope to private and public centres will enable us to get a complete picture of the arthroplasties carried out in Catalonia (reaching 100% coverage) and will enable the monitoring and surveillance of all prosthesis used in our country.

Continuous improvement of data quality. We are still making efforts to improve the quality of the information sent by centres. We periodically perform data quality reviews, schedule face-to-face meetings with centres, and promote close collaboration with professionals. However, the best way to promote and encourage participation is to make the register more useful for professionals according to their needs. This is one of the main challenges we face.

Linking the RACat with different databases. In recent years, we have carried out *ad-hoc* linkages with databases in order to answer specific research questions arising out ofdifferent projects. This has enabled collaborations with researchers from other disciplines and has enhanced the possibilities of data exploitation. We hope to consolidate past collaborations and to initiate new projects.

Promote dissemination. Participation in scientific forums and international networks will promote the visualization and dissemination of the RACat both inside Catalonia and beyond our borders. In this line, we have planned to improve the information displayed on our website to make it more attractive, visual, and current.

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