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RESEARCH ARTICLE

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Socioeconomic inequalities in waiting times for planned and cancer surgery: Evidence from Spain

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Abstract

Waiting times act as a non-price rationing mechanism to bring together the demand for and the supply of public healthcare services and ensure equal access independently of ability to pay. This study tests for the presence of socioeconomic inequalities in waiting times for ten publicly-funded planned and cancer surgeries in Catalonia (Spain) in 2015–2019. Socioeconomic status (SES), measured by four categories (very low, low, middle, high), is based on co-payment levels for medicines which depend on patient's income. Using administrative data, we estimate the association between SES and waiting times controlling for patient characteristics and hospital fixed effects. Compared to patients with low SES, patients with middle SES wait 2–6 fewer days for hip replacement, cataract surgery, and hysterectomy, and less than a day for breast cancer surgery. These inequalities arise within hospitals and are not explained by patient nor hospital characteristics. For some surgeries, the results also show that patients with higher SES are more likely to voluntarily exit the waiting list and have a lower probability of having a surgery canceled for medical reasons and dying while waiting.

KEYWORDS
healthcare inequalities, socioeconomic status, waiting times

JEL CLASSIFICATION
I11, I14

1 | INTRODUCTION

Many OECD countries consider waiting times as a significant health policy issue (Siciliani et al., 2013). Publicly-funded health systems, with excess demand due to capacity constraints and limited or no co-payments, rely on waiting times as a form of non-price rationing to reach equilibrium between the demand for and the supply of health services (Martin & Smith, 1999).

The main justification for rationing public healthcare by waiting times, rather than price, is that access to health services should not depend on ability to pay. Instead, patients in equal need, severity or complexity should wait the same, irrespective of their ability to pay or geographic and social characteristics such as distance from the hospital and socioeconomic status (SES).

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More severe patients instead should wait less, if the disutility from waiting is higher for patients with higher need, based on prioritization or urgency protocols (Gravelle & Siciliani, 2008; Gutacker et al., 2016), but not ability to pay. Waiting lists are therefore perceived as a way of ensuring equal access to public healthcare.

A growing literature however suggests that patients with higher SES (mostly measured by income and education) wait less for public healthcare than patients with lower SES (see Landi et al. (2018) and Siciliani (2016) for literature reviews). This literature found evidence of socioeconomic inequalities in waiting times across planned procedures (e.g., hip replacement, knee replacement, cataract surgery) and also more urgent ones (e.g., coronary artery bypass surgery (CABG), cancer care), and across several countries such as England (Cooper et al., 2009; Laudicella et al., 2012; Moscelli et al., 2018), Norway (Carlsen & Kaarboe, 2015; Kaarboe & Carlsen, 2014; Monstad et al., 2014), Australia (Johar et al., 2013; Sharma et al., 2013), Sweden (Tinghög et al., 2014), Italy (Petrelli et al., 2012), Denmark (Simonsen et al., 2020), France (Ayrault-Piault et al., 2016), Colombia (Piñeros et al., 2011), and USA (Gorey et al., 2009). Hence, waiting times may not be as equitable as they appear for several hospital procedures.

The aim of this study is to quantify socioeconomic inequalities in inpatient waiting times for publicly-funded hospital surgeries in Catalonia over 2015–2019. We focus on six planned surgeries (hip replacement, knee replacement, cataract surgery, hysterectomy, prostatectomy, and CABG) and four cancer surgeries for cancers with highest incidence rates (prostate, female breast, colorectal, and lung cancer surgery) among OECD countries (OECD, 2019).

Catalonia is a region in the North East of Spain with a population of 7.7 million (16.2% of the Spanish population) in 2020 (National Statistics Institute, 2020). Catalonia has an income inequality above the European Union average but below the Spanish average (Statistical Institute of Catalonia, 2022).[1] Recent studies found a pro-rich socioeconomic gradient in several health indicators (mortality, morbidity, public healthcare utilization, and consumption of medicines) in Catalonia (Carrilero et al., 2020; García-Altés et al., 2018). Given this socioeconomic gradient, Catalonia is an interesting case to analyze if socioeconomic inequalities arise in another dimension of public healthcare, namely waiting times.

We use administrative cross-sectional data of patients receiving a given procedure over 2015–2019. Our econometric strategy employs linear regression models of inpatient waiting time against SES measured by four mutually exclusive categories (very low, low, middle, and high SES) based on co-payment levels for medicines which depend on patient's annual gross income or Social Security benefits (García-Altés et al., 2018). We use a range of controls that relate to patient characteristics (i.e., gender, age, comorbidities, primary diagnosis, procedure type, nationality, year of addition to the waiting list, month of hospital admission, and area of residence) and type of hospital (i.e., public, private, teaching).

The study also tests whether such waiting time inequalities arise *within* hospitals or *across* hospitals. Inequalities can arise *within* hospitals if patients with differing SES who attend the same hospital have different waiting times. For instance, patients with higher SES may have a better understanding and be more familiar with the administrative processes to access specialist services, put pressure to the provider through frequent phone calls or rely on informal channels (e.g., knowing someone working at the hospital). Inequalities may arise *across* hospitals if individuals with higher SES live in areas and attend hospitals with higher capacity and shorter waiting times.

Last, we investigate whether the likelihood of exiting the waiting list for reasons other than surgery varies by SES. We focus on three possible reasons. The first is demand driven and relates to patients voluntarily exiting the waiting list. The second is supply driven and relates to the surgery being canceled for medical reasons. The third is whether the patient dies while waiting on the list. We investigate whether the probability of exiting the waiting list for each of these reasons differs by SES relative to a patient pathway ending with the patient receiving the surgery.

The results show that socioeconomic inequalities in waiting times arise *within* hospitals. Relative to patients with low SES, patients with middle SES wait less by 4.8 days for hip replacement, 2.4 days for cataract surgery, 6.1 days for hysterectomy, and 0.5 days for breast cancer surgery. We instead find no differences for the remaining of the procedures. Similarly, relative to low SES, patients with very low SES (who account for at most 5.8% of the sample) wait longer by 5.6 days for hip replacement, 14.2 days for CABG, 3.5 days for prostate cancer surgery, 2.3 days for colorectal cancer surgery, with no differences for the other procedures.

We also show that the probability of voluntarily exiting the waiting list is larger by 0.4–1.2 percentage points (p.p.) for patients with higher SES for knee replacement, cataract surgery, prostatectomy, and breast cancer surgery. This could be due to patients with higher SES deciding to seek treatment in another public or private hospital while waiting. Patients with higher SES may convey their needs more effectively to clinicians who can facilitate seeking treatment in another (public or private) hospital with shorter waiting times. Instead, patients with higher SES have a lower probability of having a surgery canceled for medical reasons by 0.3p.p. for cataract surgery and 0.5p.p. for breast cancer surgery. This may be due to poorer people being in worse health, translating into further delays along the patient pathway. These results suggest that patients with lower SES have poorer access to health care, not only in the form of longer waiting time, but also in terms of higher cancellations. The

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probability of dying while waiting is 0.1–0.3p.p. lower for patients with higher SES for hip replacement, cataract surgery, and hysterectomy.

We make three main contributions to the literature. First, this is the first study analyzing socioeconomic inequalities in waiting times in Spain using administrative data. Health systems differ in the organization and financing of health services. Countries also differ in culture and institutions. It is therefore difficult to translate the findings from previous studies into the Spanish context. Studies using administrative data are clustered in England, the Nordic countries, and Australia (see Section 2). The English National Health Service, like the Spanish one, is based on a publicly-funded health system, but patient choice and competition across providers are pervasive, while they are limited in the context of Catalonia. The Nordic countries, such as Norway and Sweden, have significantly higher health expenditure per capita,[2] more generous welfare states and smaller income inequalities.[3] Australia has compulsory public health insurance, but almost 50% of the population have private health insurance to avoid long waiting times (Sharma et al., 2013), while this rate is considerably smaller (around 16% in 2017) in Spain (National Statistics Institute, 2018). Three previous studies used survey data to analyze the Spanish case. These surveys are less representative of patient population relative to administrative data and bundle together very different health treatments and procedures with limited control variables for patient's severity. Siciliani and Verzulli (2009) used the 2004 Survey of Health, Aging and Retirement in Europe for nine countries, including Spain. They found that Spanish patients with higher education wait 3.6 weeks less for a specialist consultation, while no gradient is reported for planned surgery. Abásolo et al. (2014) used the 2006 Spanish National Health Survey and found that patients with no or primary education wait 18%–28% more than patients with university education for specialist consultations. They also found that a 1% increase in income reduced waiting times by 0.3%. García-Corchero and Jiménez-Rubio (2022) used survey data from the Spanish Health Barometer for 2010–2019 and showed that patients with university education wait 9–16 days less for specialist visits, while there is no gradient for general practitioner (GP) visits.

Second, the study investigates inequalities for four types of cancer surgery, while most of the health economics literature has focused on planned surgical procedures (e.g., Monstad et al. (2014); Moscelli et al. (2018); Simonsen et al. (2020)). This is surprising given that cancer is at the top of the policy agenda among OECD countries and the second cause of mortality after circulatory diseases, with 25% of all deaths due to cancer in 2017 (OECD, 2019). Some clinical studies analyzed waiting times for breast cancer surgery, but these have relatively small samples (around 1000 patients; see Ayrault-Piault et al. (2016) for France, Gorey et al. (2009) for Canada and Piñeros et al. (2011) for Colombia). Redaniel et al. (2013) used a larger sample of English women with breast cancer, although their SES variable is at the small-area level and they do not consider hospital characteristics or fixed effects.

Third, the literature on socioeconomic inequalities in waiting times has focused on patients whose waiting time ends with a surgery. One policy concern is that while on the list, patients' circumstances may change and end up never receiving the treatment. This could be due to their condition deteriorating, the patient changing their mind or seeking treatment in the private sector, or at one extreme dying while waiting. In turn, these reasons for exiting the list while waiting could be related to SES. Differently from previous literature, we can explore these different channels by looking at the probability of exiting the waiting list for different reasons, whether the patient voluntarily exits the list, whether the surgery is canceled for medical reasons, or whether the patient dies while waiting.

The remainder of this study is structured as follows. Section 2 reviews the literature. Section 3 describes the institutional setting. Sections 4 and 5 describe data and methods, respectively. Section 6 presents and discusses the results. Section 7 concludes.

2 | RELATED LITERATURE

A growing empirical literature provides evidence that patients with higher SES have shorter waiting times than patients with lower SES for several publicly-funded surgeries (see Landi et al. (2018) and Siciliani (2016) for literature reviews). Laudicella et al. (2012) showed that for hip replacement in England, patients who are education- and income-deprived have longer waiting times by 9% and 7%, respectively, and these inequalities arise *within* hospitals. Moscelli et al. (2018) showed that most deprived patients wait 10%–34% and 12%–53% more for CABG and percutaneous coronary intervention and patient choice explains up to 12% and 7% of the gradient, respectively, in England over 2002–2010.

Several studies in the Nordic countries also investigated and generally confirmed the presence of socioeconomic inequalities in waiting times. Kaarboe and Carlsen (2014) used Norwegian registry data in 2004–2005 and found that men with higher education wait about 15% less, while women with higher education and income wait 28% and 11% less, respectively. Using similar data, Carlsen and Kaarboe (2015) focused on elderly patients and found that men with secondary education and women

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with more than primary education wait about 16% and 15% less, respectively. Both studies concluded that these gradients vanish when controlling for hospital-specific factors such as attending the local hospital, travel distance and supply of private specialists. Monstad et al. (2014) analyzed hip replacement in Norway and found that men with higher income and women with higher education wait 25 and 12 fewer days, respectively, after controlling for hospital fixed effects.

Tinghög et al. (2014) employed administrative data in Sweden for six planned procedures in 2007. They found that patients in the lowest income tercile wait more for orthopedic surgery (27% more) and general surgery (34% more), but no gradient was found for vascular, gynecology, urology, and ophthalmology surgeries. Using administrative data in Denmark in 2013–2015, Simonsen et al. (2020) showed that patients with higher education wait 3%–16% less for cataract surgery, and those in the highest income decile wait 9%–18% less. This gradient vanishes after controlling for hospital fixed effects implying that inequalities arise *across* hospitals. Instead, there is no socioeconomic gradient for hernia surgery, gallstone surgery, hip and knee replacement, prostatectomy, and hysterectomy. For Australia, Johar et al. (2013) found that patients with lower SES wait 16%–24% longer for any acute illness, while Sharma et al. (2013) showed that those living in more affluent areas wait 13% shorter for planned surgery and selection of richer patients opting for surgery in private hospitals reduces significantly the gradient.

Siciliani and Verzulli (2009) employed the 2004 Survey of Health, Aging and Retirement in Europe for nine countries and found that patients with higher education wait less for planned surgeries in Denmark (66% less), the Netherlands (32% less), and Sweden (48% less), but no gradient was found in France, Greece, Italy, and Spain. Instead, richer patients wait 26% shorter in Greece but 11% longer in Sweden.

Some studies focused on breast cancer and provided evidence of socioeconomic inequalities in waiting times in France (Ayrault-Piault et al., 2016), USA (Gorey et al., 2009), and Colombia (Piñeros et al., 2011), while no gradient was found in England (Redaniel et al., 2013) and Canada (Gorey et al., 2009).

3 | INSTITUTIONAL BACKGROUND

The Spanish National Health System (NHS) provides universal healthcare coverage since 1986 (LGS, 1986) and it is publicly-funded through general taxation. The NHS is free at the point of use, with the exception of co-payments for prescribed medicines (Bernal-Delgado et al., 2018). The NHS coexists with civil servants' health insurance[4] and voluntary private health insurance (Jiménez-Martín & Viola, 2016).[5]

After the Spanish constitution of 1978, health competences were decentralized and transferred from the central government to the 17 Spanish regions (García-Armesto et al., 2010). The national Ministry of Health is accountable for basic health legislation, general coordination of health services, and pharmaceutical policy, while the regional Departments of Health are responsible for the funding, organization and delivery of health services within their territory (García-Armesto et al., 2010). Catalonia obtained regional authority over health in 1981 (Costa-Font & Rico, 2006).

The Catalan territory is split into seven health regions further divided into "basic health areas" that organize public primary care[6] (Pelegrí Viaña, 2011). GPs provide primary care and act as gatekeepers to access specialist care. Patient choice is mainly limited to primary care (García-Armesto et al., 2010) since patients cannot choose hospital and GPs cannot refer patients to specific hospitals. Instead, the health regions regulate the assignment of patients to hospitals which depends on patient's residence. The hospital assigned to a patient might not provide the necessary treatment for certain more specialized conditions. If that is the case, the patient is referred to another hospital providing the required treatment but conditional on patient's residence. Eight hospitals are public and run directly by the Catalan Health Institute, while the remaining are private not-for-profit hospitals under public contracts. Both public and private not-for-profit hospitals can provide teaching activities and only offer healthcare to publicly-funded patients.

Given the limited capacity, hospitals have long waiting lists and patients can wait a long time for planned care. For surgeries, the waiting lists are managed by the specialists who make decisions about whether and when adding the patient to the waiting list. Patients are added to the waiting lists based on prioritization criteria such as patient's severity, limitation of daily life activities and family dependency (Solans et al., 2012). Patients can always opt for surgery in the private sector with shorter waiting times at their own expense if they pay out-of-pocket or hold private health insurances.[7]

A maximum waiting time guarantee of six months was introduced in 2002 for 14 planned surgical procedures[8] (DOGC, 2002). In 2015, some of the original procedures were eliminated and others were added. The revised list included cataract surgery, hip and knee replacement with a maximum waiting time guarantee of 180 days, major cardiac surgeries with a maximum of 90 days, surgical procedures for cancer of bladder and prostate with a maximum of 60 days, and for the remaining cancers with a maximum of 45 days (DOGC, 2015a). The Catalan Health Service can transfer patients to other hospitals in its network to ensure that the maximum waiting time guarantee is satisfied (DOGC, 2002).[9]

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Since 2015, patients undergoing one of the remaining planned surgeries without a maximum time guarantee are covered by a maximum reference waiting time (DOGC, 2015b), which is the maximum time that patients should wait given their health characteristics and priority in the list. This maximum waiting time is set by health professionals and relies on the prioritization of patients based on the impact of the illness to the quality of life, risks associated to waiting, and clinical effectiveness, amongst other criteria (DOGC, 2015b). Patients have a maximum waiting time of 90, 180, and 365 days depending on priority (DOGC, 2015b).

4 | DATA

The study employs three administrative data sources: the Health Waiting Lists Database, the Central Registry of Insured Persons, and the Registry of the Minimum Basic Dataset. We merge them through the patient's healthcare ID, a unique identifier for residents in Catalonia. We analyze publicly-funded patients added to the hospital waiting list of the Catalan Health Service between 2015 and 2019 (Table A1 in Appendix A for detailed sources).

4.1 | Waiting times

Waiting times are retrieved from the Health Waiting Lists Database and the Registry of the Minimum Basic Dataset. The Health Waiting Lists Database covers all patients registered in the waiting list to have a surgery, a diagnostic test or a specialist visit. The Registry of the Minimum Basic Dataset includes all contacts with the public healthcare system, including hospital care, and contains detailed patient-level information, such as clinical diagnoses, procedures, and date of admission and discharge.

The sample comprises all patients added to the waiting list for a surgery between 2015 and 2019. We analyze six planned surgeries (hip and knee replacement, cataract surgery, hysterectomy, prostatectomy,[10] and CABG) and four cancer surgeries (prostate, female breast, colorectal, and lung cancer surgery[11]). For cancer, we include malignant neoplasms and carcinomas in situ, but exclude benign neoplasms and secondary malignant neoplasms, and focus on curative surgeries (e.g., breast-conserving surgery and mastectomy for female breast cancer).[12]

Following the OECD,[13] we define inpatient waiting times as the number of days from the date patients are added to the waiting list by indication of the specialist doctor (reported in the Health Waiting Lists Database) to the date they are admitted to hospital for treatment (reported in the Registry of the Minimum Basic Dataset). We exclude waiting times above three standard deviations from the mean and patients below the age of 18 (0.71% of the sample). We also exclude patients with a waiting time of zero or 1 day, as we consider these being emergency admissions mistakenly coded in the waiting list (0.67% of the sample).

We also construct a dummy variable equal to one if patient's waiting time exceeds the maximum time guarantee, and zero otherwise. As mentioned in Section 3, the maximum time guarantee is 45 days for cancer surgery, except prostate cancer surgery which is 60 days, 90 days for CABG, and 180 days for cataract surgery, hip and knee replacement (DOGC, 2015a).

Patients can exit the list while waiting for reasons other than surgery. For example, patients can voluntarily decide to exit the waiting list, their surgery may be canceled for medical reasons, or they might die while waiting. We construct binary variables equal to one for each of these exiting reasons, and zero for undergoing surgery. The patient's reason for exiting the waiting list is found in the Health Waiting Lists Database.[14]

4.2 | Socioeconomic status

The Central Registry of Insured Persons is a database collecting information on all individuals holding a healthcare card including socioeconomic characteristics from which the Agency for Health Quality and Assessment of Catalonia calculates patient's SES. The SES is based on the level of co-payment of medicines which depends on individual's annual gross income or Social Security benefits. Patient's level of co-payment is not generally observable to healthcare providers and GPs, although GPs can know if the patient is employed or retired.

The SES is a categorical variable formed by four mutually exclusive groups (García-Altés et al., 2018): (1) very low SES (individuals receiving welfare benefits from the government, unemployment benefits or allowances, or non-contributory pensions who do not pay co-payment), (2) low SES (individuals with an annual gross income of less than €18,000 derived from employment earnings and contributory pensions who pay 40% and 10% co-payment, respectively), (3) middle SES (individuals with an annual gross income between €18,000 and €100,000 derived from employment earnings and contributory pensions who

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pay 50% and 10% co-payment, respectively), and 4) high SES (individuals with an annual gross income of more than €100,000 derived from employment earnings or contributory pensions who pay 60% co-payment) (Real Decreto-ley, 2012).[15]

4.3 | Control variables

We include several patient-level explanatory variables to control for the severity of patient's health condition. We control for gender with a dummy equal to one if the patient is a female, and for age split into six age bands: 18–45, 46–55, 56–65, 66–75, 76–85, and 85+.

We also use the Spanish population grouping and risk stratification tool known as the Adjusted Morbidity Groups (GMA), which groups patients by complexity through a complexity score (Carrilero et al., 2020; Cerezo Cerezo & Arias López, 2018; Monterde et al., 2016). We use this GMA score to split patients into four levels (Ministry of Health, Consumer Affairs and Social Welfare, 2018): basal risk (complexity score lower than the 50th percentile of the population distribution), low risk (score between the 50th and 80th percentiles), moderate risk (score between the 80th and 95th percentiles), and high risk (higher than the 95th percentile). The Catalan Health Service and the Catalan Health Institute computed the GMA scores employing data from the Registry of the Minimum Basic Dataset (Monterde et al., 2016). Therefore, patient's GMA score is observable to researchers but not observable to healthcare providers and clinicians responsible for adding patients to the waiting list.[16] We also include primary diagnosis and procedure type from the Health Waiting Lists Database.[17]

We add patient's nationality through a categorical variable with five groups retrieved from the Central Registry of Insured Persons: Spanish, 27-European Union and UK, Northern Africa, the Caribbean and Central and South America, and the rest of the world.[18] We also measure the year when the patient was added to the waiting list (2015–2019) from the Health Waiting Lists Database, the month of hospital admission from the Registry of the Minimum Basic Dataset, and the "basic health area" of residence from the Central Registry of Insured Persons.

Finally, we group hospitals into four categories: public teaching hospitals, public non-teaching hospitals, private not-for-profit teaching hospitals, and private not-for-profit non-teaching hospitals.

5 | METHODS

To analyze socioeconomic inequalities in waiting times, we use the following model:

$$w_{ijt} = \beta_0 + \boldsymbol{y}'_{it}\boldsymbol{\beta}_y + \boldsymbol{x}'_{it}\boldsymbol{\beta}_s + \lambda_t + \varepsilon_{ijt} \tag{1}$$

where w_{ijt} is the waiting time (in days) for patient i, in hospital j, and year t in which the patient was added to the waiting list. $\boldsymbol{y}_{it}$ is a vector of variables related to SES: very low, low, medium, and high (see Section 4 for a detailed description). We use low SES as the reference category given that it has the greatest proportion of patients (see Section 6 below). $\boldsymbol{x}_{it}$ is a vector of patient characteristics (i.e., gender, age, GMA score, primary diagnosis, procedure type, nationality, and month of hospital admission). These covariates are added to analyze whether patient's severity and other characteristics explain the gradient between SES and waiting times. $\boldsymbol{x}_{it}$ also includes the patient's "basic health area" of residence. For instance, poorer patients may be concentrated in more deprived areas with less developed infrastructure (e.g., roads, public transports, Internet connection) that might slow down their communication with the healthcare system and increase their waiting times. $\boldsymbol{\lambda}_t$ is a vector of year fixed effects to control for time trends in waiting times either on the demand side (e.g., aging population and advances in medical technology that make safer to treat more patients) or the supply side (e.g., changes in health funding). ε_{ijt} is the error term.

We estimate (1) by Ordinary Least Squares with robust-heteroskedastic standard errors clustered at hospital level.[19] The coefficients of interest are β_y, which give an estimate of the socioeconomic gradient in waiting times after controlling for some dimensions of need captured by several patient characteristics.[20,21] Some of the socioeconomic gradient in waiting times could be due to patients attending different types of hospital. For example, public hospitals may have longer waiting times (due to higher demand) and patients with lower SES may be more likely to attend a public hospital. Teaching hospitals have additional costs due to training responsibilities (López-Casasnovas & Saez, 1999) with teaching being perceived as a marker of quality. We therefore augment Equation (1) with a vector of variables, defined as $\boldsymbol{h}_j$, related to types of hospital.

Part of the socioeconomic inequalities in waiting times may arise *across* hospitals if individuals with higher SES live in areas and attend hospitals with higher supply (e.g., more beds, doctors, nurses) and shorter waiting times, while part of the inequalities may arise *within* hospitals if patients with differing SES attending the same hospital experience different waiting

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times. The latter could be, for example, due to some patients getting ahead in the queue by pressuring the provider (e.g., frequent phone calls), through informal channels (e.g., knowing someone working at the hospital), or by expressing their needs more effectively, among others (Siciliani, 2016). To assess whether inequalities arise *within* or *across* hospitals, we use the following model:

$$w_{ijt} = \beta_0 + \boldsymbol{y}'_{it}\boldsymbol{\beta}_y + \boldsymbol{x}'_{it}\boldsymbol{\beta}_s + \lambda_t + \boldsymbol{\theta}_j + \varepsilon_{ijt} \quad (2)$$

which adds a vector of hospital fixed effects θ_j to Equation (1). The coefficients β_y can now be interpreted as inequalities arising *within* the hospital (Laudicella et al., 2012; Moscelli et al., 2018). We also estimate (2) by Ordinary Least Squares with robust-heteroskedastic standard errors clustered at hospital level.

As an alternative dependent variable, we use a dummy variable equal to one if patient's waiting time exceeds the maximum waiting time guarantee. We estimate this alternative version as a linear probability model. We also employ a linear probability model to explore socioeconomic inequalities in the probability of exiting the list while waiting (due to the patient voluntarily exiting the waiting list, the surgery being canceled for medical reasons, or the patient dying) relative to receiving a surgery. We run separate regressions for each reason of exiting the waiting list.

Last, given the large number of surgeries, we check the robustness of our results to adjusting the *p*-values for multiple hypotheses testing (known as *q*-values) following Benjamini and Hochberg (1995) and Anderson (2008) to control for the false discovery rate (i.e., the expected proportion of rejections that are type-I errors). This method has greater power and reduces the penalty to testing additional hypotheses compared to the familywise error rate controlling methods such as the Bonferroni correction (Anderson, 2008; Benjamini & Hochberg, 1995).

6 | RESULTS

6.1 | Descriptive statistics

Table 1 presents summary statistics. The mean waiting time is 149 days for hip replacement, 170 days for knee replacement, and 123 days for cataract surgery. For more urgent surgeries, the mean waiting time is 153 days for prostatectomy, 131 days for hysterectomy, and 38 days for CABG. Waiting times for cancer surgery are generally shorter: 21 days for female breast cancer surgery, 53 days for prostate cancer surgery, 24 days for colorectal cancer surgery, and 30 days for lung cancer surgery.[22] Figure B1 in Appendix B shows that the waiting times' kernel distribution by surgery is right-skewed, but the skewness is not pronounced.

Depending on the procedure, about 1.7%–5.8% of patients have very low SES, 48.8%–74.4% have low SES, 20.8%–48.2% have middle SES, and 0.1%–1.2% have high SES. Respectively, 45.8% and 68.1% of hip and knee replacement patients are females, and 57.3% for cataract surgery. Instead, only 13% of CABG patients are females, while this is 38.7% and 27.9% for colorectal and lung cancer surgery, respectively. The average age of patients with hip and knee replacement is 66.3 years old and 71, respectively, and for cataract surgery is 73.8. Patients are 69.9 years old for prostatectomy, 54.7 for hysterectomy, and 65.4 for CABG on average. For cancer surgery, the average age ranges from 60.4 (breast cancer surgery) to 68.9 (colorectal cancer surgery) with the other two surgeries involving patients who are on average 65 years old. In terms of the GMA score, more than 50% of patients with CABG and colorectal and lung cancer surgery are considered to be of high risk, while most patients (43.3%–58.6%) for the remaining surgeries have moderate risk.

About 86.4%–97.2% of patients have a Spanish nationality, depending on the procedure. 0.8%–2.5% have a nationality from the European Union or UK, 0.3%–1.4% from Northern Africa, and 0.7%–6.9% from the Caribbean and Central and South America. The samples are uniformly distributed across 2015–2019. A higher proportion of surgeries are provided in October and November, with the lowest proportion in January and August coinciding with holiday periods.

Except for CABG and lung cancer surgery, most patients had a surgery with a private not-for-profit hospital, either a teaching (25.3%–32.3%) or a non-teaching one (36.9%–53%), with the remaining being treated in public teaching hospitals (16%–29.7%) and a negligible proportion in public non-teaching hospitals (0.8%–2.8%). Most patients in need of a CABG and lung cancer surgery were instead treated by public teaching hospitals (60.9%).

Table 2 reports waiting times by SES and shows that waiting times monotonically decrease as SES increases for hip and knee replacement. This is also generally the case for colorectal and lung cancer surgery, although low and middle SES patients have similar waiting times. Instead, waiting times follow an inverted-U shape for cataract surgery, prostatectomy, hysterectomy, and breast and prostate cancer surgery. There is no consistent pattern for CABG.[23]

TABLE 1 Descriptive statistics.

Variable	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
Waiting times in days	149.2	170.4	122.9	152.9	131.4	38.44	20.97	52.92	24.25	30.09
Maximum time guarantee	0.329	0.395	0.187	-	-	0.098	0.057	0.352	0.115	0.200
Socioeconomic status										
Very low	0.035	0.037	0.039	0.019	0.058	0.042	0.048	0.017	0.029	0.036
Low	0.682	0.740	0.744	0.602	0.732	0.630	0.680	0.488	0.666	0.626
Middle	0.280	0.222	0.216	0.374	0.208	0.324	0.269	0.482	0.301	0.332
High	0.004	0.001	0.001	0.005	0.002	0.005	0.003	0.012	0.004	0.006
Gender (=1 if female)	0.458	0.681	0.573	0.000	1.000	0.130	1.000	0.000	0.387	0.279
Age (mean)	66.34	71.02	73.81	69.90	54.70	65.37	60.38	64.85	68.85	65.44
[18, 45]	0.059	0.004	0.008	0.004	0.270	0.023	0.142	0.004	0.023	0.029
[46, 55]	0.139	0.038	0.030	0.049	0.326	0.133	0.246	0.094	0.100	0.127
[56, 65]	0.237	0.189	0.116	0.247	0.172	0.319	0.255	0.401	0.253	0.307
[66, 75]	0.311	0.456	0.384	0.437	0.165	0.381	0.200	0.450	0.314	0.391
[76, 85]	0.225	0.298	0.394	0.234	0.062	0.144	0.126	0.046	0.259	0.145
85+	0.030	0.014	0.068	0.029	0.005	0.002	0.031	0.006	0.051	0.001
GMA score										
Basal-risk	0.037	0.009	0.017	0.022	0.092	0.001	0.020	0.021	0.002	0.001
Low-risk	0.245	0.165	0.174	0.170	0.386	0.027	0.232	0.219	0.070	0.018
Moderate-risk	0.498	0.586	0.530	0.465	0.433	0.345	0.530	0.561	0.422	0.300
High-risk	0.221	0.240	0.279	0.342	0.090	0.627	0.217	0.200	0.505	0.680
Nationality										
Spanish	0.955	0.971	0.971	0.972	0.864	0.929	0.939	0.966	0.971	0.961
27-EU and UK	0.019	0.008	0.008	0.008	0.025	0.022	0.018	0.014	0.011	0.018
Northern Africa	0.003	0.004	0.006	0.005	0.014	0.004	0.010	0.004	0.004	0.005
Caribbean and Central and South America	0.012	0.010	0.008	0.007	0.069	0.010	0.020	0.011	0.007	0.007
Rest of the World	0.011	0.007	0.007	0.006	0.028	0.035	0.012	0.006	0.007	0.009
Year in waiting list										
2015	0.184	0.185	0.186	0.200	0.217	0.148	0.197	0.170	0.180	0.204
2016	0.199	0.205	0.194	0.203	0.201	0.194	0.209	0.187	0.225	0.242
2017	0.218	0.222	0.214	0.209	0.198	0.215	0.218	0.213	0.227	0.225
2018	0.196	0.206	0.201	0.189	0.198	0.233	0.162	0.202	0.179	0.140
2019	0.202	0.182	0.206	0.199	0.185	0.210	0.214	0.228	0.189	0.189
Month of hospital admission										
Jan	0.062	0.056	0.064	0.068	0.076	0.078	0.070	0.072	0.070	0.064
Feb	0.084	0.078	0.075	0.091	0.094	0.083	0.073	0.071	0.073	0.073
Mar	0.079	0.076	0.079	0.078	0.089	0.094	0.084	0.072	0.085	0.082
Apr	0.069	0.071	0.072	0.075	0.078	0.077	0.076	0.083	0.082	0.086
May	0.093	0.091	0.091	0.100	0.107	0.100	0.094	0.102	0.096	0.092
Jun	0.099	0.098	0.096	0.096	0.096	0.088	0.091	0.093	0.093	0.092
Jul	0.082	0.080	0.094	0.082	0.072	0.093	0.099	0.090	0.097	0.087
Aug	0.033	0.032	0.035	0.038	0.026	0.060	0.075	0.047	0.076	0.070
Sep	0.080	0.085	0.089	0.071	0.077	0.072	0.081	0.091	0.079	0.089
Oct	0.123	0.126	0.112	0.111	0.111	0.089	0.088	0.106	0.087	0.101

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TABLE 1 (Continued)

Variable	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
Nov	0.124	0.133	0.115	0.121	0.112	0.104	0.090	0.101	0.086	0.093
Dec	0.073	0.074	0.078	0.068	0.063	0.061	0.078	0.071	0.077	0.071
Type of hospital										
Public teaching hospital	0.173	0.160	0.172	0.229	0.235	0.609	0.297	0.297	0.265	0.609
Public non-teaching hospital	0.011	0.008	0.023	0.028	0.021	0.000	0.012	0.009	0.018	0.000
Private not-for-profit teaching hospital	0.298	0.308	0.275	0.253	0.265	0.391	0.323	0.311	0.291	0.391
Private not-for-profit non-teaching hospital	0.518	0.524	0.530	0.491	0.479	0.000	0.369	0.384	0.426	0.000
Observations	16,903	34,550	258,695	14,014	11,174	1758	17,762	4659	12,011	3255

Note: Descriptive statistics for dependent, independent, and control variables. Descriptive statistics for waiting times and age are in means, while for the remaining variables are in proportions. Descriptive statistics on procedure type, primary diagnosis, "basic health area" of residence, and hospital fixed effects are not reported for the sake of brevity.

Table 3 shows the number and proportion of patients by reason for exiting the waiting list. The most common reason is having a surgical procedure ranging from 85.5% for knee replacement to 97.1% for breast cancer surgery. Two other common reasons, with much smaller proportions, are whether the patient voluntarily exits the waiting list (ranging from 0.9% for colorectal cancer to 11.1% for knee replacement) or the surgery is canceled for medical reasons (ranging from 1.2% for cataract surgery to 5.5% for CABG). A smaller proportion of patients die while waiting (from no patient for prostate cancer surgery to 0.7% for prostatectomy).

6.2 | Main results

Table 4 presents the results for our preferred specification, which controls for patient characteristics and hospital fixed effects. The results show that there is a pro-rich socioeconomic gradient in waiting times *within* hospitals for eight out of 10 surgeries.

We first compare differences in waiting times between low SES (our reference group) and middle SES. This comparison is important because at least 48.8% of patients have low SES, and at least 20.8% of patients have middle SES. Relative to patients with low SES, for *hip replacement*, patients with middle SES wait less by 4.8 days (3.2% less, mean wait of 149.2 days); for *cataract surgery*, they wait 2.4 days shorter (2% less, mean wait of 122.9 days); for *hysterectomy*, they wait 6.1 fewer days (4.6% less, mean wait of 131.4 days); and for *female breast cancer* surgery, they wait 0.5 fewer days (2.4% less, mean wait of 21 days). We instead find no differences for the remaining of the procedures.

There are differences in waiting times between low and very low SES, though the latter accounts for at most 5.8% of the sample. Relative to low SES, for *hip replacement*, patients with very low SES wait 5.6 days longer (3.8% more, mean of 149.2 days); for *CABG*, they wait 14.2 longer (37% more, mean of 38.4 days); for *prostate cancer* surgery, they wait 3.5 days longer (6.6% more, mean of 52.9 days); and for *colorectal cancer* surgery, they wait 2.3 days longer (9.5% more, mean of 24.3 days). No differences are found for the other procedures.

We also find differences in waiting times between low and high SES, though note that the latter comprises at most 1.2% of the sample and less than 0.6% of the sample for all except for prostate cancer surgery. Relative to patients with low SES, for *hip replacement*, patients with high SES (0.4% of the sample) wait less by 21.1 days (14.1% less, mean of 149.2 days); for *knee replacement*, they wait 36.7 fewer days (21.5% less, mean of 170.4 days) though only 0.1% of patients have high SES; and for *cataract surgery*, they wait 21.6 days shorter (17.6% less, mean of 122.9 days) but again only 0.1% of patients have high SES.[24] Table B7 in Appendix B shows that the statistically significance of the results barely varies after controlling for multiple hypotheses testing.

Other patients' characteristics are associated with waiting times. Women and men do not differ in waiting times across all procedures, except for hip replacement. There are some differences in waiting times in relation to age.[25,26] We find marked differences in waiting times in relation to patient's complexity and comorbidities, as measured by GMA scores, for most procedures. For hip replacement, relative to patients with basal risk, patients with high risk wait 19.9 fewer days (13.3%). For knee

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TABLE 2 Average waiting time by socioeconomic status.

Socioeconomic status	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
Very low	154.5	173.8	119.9	144.4	127.3	45.61	20.85	53.44	26.07	32.51
Low	150.3	170.9	123.9	151.1	132.3	36.39	21.09	53.75	24.09	30.01
Middle	146.0	168.3	120.1	156.4	129.3	41.67	20.70	52.24	24.47	30.03
High	121.5	133.6	94.60	134.08	123.86	24.38	20.63	46.43	20.61	27.15

Note: Average waiting time in days by socioeconomic status and surgery.

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TABLE 3 Number and proportion of patients by reason for exiting the waiting list.

	Hip replacement		Knee replacement		Cataract surgery		Prostatectomy		Hysterectomy	
Reason	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**
Surgical procedure	16,903	89.24%	34,550	85.50%	258,695	94.70%	14,014	88.67%	11,174	91.86%
Patient voluntarily decides to exit the waiting list	1414	7.47%	4471	11.06%	10,252	3.75%	1090	6.90%	733	6.03%
Surgery canceled for medical reasons	560	2.96%	1312	3.25%	3201	1.17%	594	3.76%	247	2.03%
Death	64	0.34%	78	0.19%	1020	0.37%	107	0.68%	10	0.08%
Total	18,941	100%	40,411	100%	273,168	100%	15,805	100%	12,164	100%
	CABG		**Female breast cancer surgery**		**Prostate cancer surgery**		**Colorectal cancer surgery**		**Lung cancer surgery**	
Reason	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**	**Number**	**Prop.**
Surgical procedure	1758	91.66%	17,762	97.12%	4659	94.03%	12,011	96.44%	3255	95.74%
Patient voluntarily decides to exit the waiting list	48	2.50%	182	1.00%	183	3.69%	113	0.91%	34	1.00%
Surgery canceled for medical reasons	106	5.53%	343	1.88%	113	2.28%	323	2.59%	109	3.21%
Death	6	0.31%	2	0.01%	0	0.00%	7	0.06%	2	0.06%
Total	1918	100%	18,289	100%	4955	100%	12,454	100%	3400	100%

replacement, relative to those with basal risk, patients with high risk wait 18.3 fewer days (10.7%). For cataract surgery, the differences across risk groups are less than 2 days, and therefore much less pronounced. The differences by complexity and comorbidities are most pronounced for prostatectomy and hysterectomy. For prostatectomy, relative to patients with basal risk, patients with high risk wait 55.6 fewer days (36.4%). For hysterectomy, patients with high risk wait 45.7 fewer days (34.8%). Differences are less pronounced for cancer surgeries. For breast cancer surgery, patients with higher risk wait at most 1.7 days shorter. Instead, for prostate cancer surgery, patients with higher risk tend to wait 3–4 days longer.[27]

Overall, these results suggest that patients are generally prioritized on the list, especially in relation to patient's complexity and comorbidities. When comparing patients with low SES with those with middle SES, which account together for at least 90% of patients, differences in waiting times are at most 5–6 days for hip replacement and hysterectomy, about 2 days for cataract surgery, less than a day for breast cancer surgery, and not statistically significant for the other procedures.

To gain some further insights into possible sources of inequalities, we present alternative specifications in Table B10 in Appendix B. We first present the raw socioeconomic gradient in waiting times without any controls. Some of this gradient could be explained by a different patient case-mix, patients' residence or type of hospital. The comparison of the results in the second, third and fourth columns in Table B10 are broadly in line with those in the first column suggesting that variations in waiting times by case-mix, "basic health area" of residence and hospital type do not explain the gradient. This conclusion is further reinforced by the comparison of the last specification in Table B10 (with hospital fixed effects). The waiting time gradients by SES are very similar, suggesting that inequalities in waiting times arise *within* hospitals.[28]

6.3 | Type of hospital

Column 4 of Table B10 shows that the socioeconomic gradient in waiting times does not vary when controlling for hospital type, suggesting that there is no association between SES and type of hospital, whether public versus private not-for-profit, or teaching versus non-teaching. There are two possible explanations for this result. The first is that waiting times differ by hospital type, but patients with higher SES are not more likely to be treated by hospital types with shorter wait. The second possibility is that waiting times do not differ by hospital type. In Table 5, we report the association between waiting times and type of hospital.

Table 5 shows that waiting times are generally shorter for private not-for-profit hospitals and therefore gives support for the first explanation that SES is not correlated with hospital type.[29] Relative to public teaching hospitals, private not-for-profit teaching hospitals have shorter waiting times for knee replacement (30.4 days shorter or 17.8% less), cataract surgery (34.9 fewer days or 28.4% less), prostate cancer surgery (7.6 fewer days or 14.4% less) and colorectal cancer surgery (5.2 fewer days or 21.4% less). Waiting times are also shorter for private not-for-profit non-teaching hospitals.[30] These results suggest that

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TABLE 4 Results for Waiting Time Inequalities by Socioeconomic Status (*within* hospitals).

	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
Socioeconomic status (baseline: Low)										
Very low	5.57**	1.34	−0.01	3.45	−2.82	14.22**	−0.23	3.45**	2.29***	0.64
Middle	−4.84***	−1.35	−2.41***	1.63	−6.07**	1.25	−0.52***	−1.26	0.02	−0.02
High	−21.09**	−36.66***	−21.63***	−15.13	−26.85	−16.18	−0.90	−5.78*	−3.06	0.56
Gender (=1 if female)	−2.89**	0.68	0.39	-	-	2.33	-	-	−0.15	0.73
Age (baseline: [66, 75])										
[18, 45]	−9.12***	3.75	−24.70***	−13.05	14.47**	1.95	−0.54	4.29	−1.99	−0.93
[46, 55]	−3.41**	−3.08	−19.38***	−14.47***	11.50**	−5.84***	−0.58	0.62	−0.73	−2.08**
[56, 65]	0.58	−2.70**	−9.07***	−4.50	0.39	−3.09	−0.16	−0.30	−0.01	−0.92**
[76, 85]	−3.24**	−3.15***	1.19***	−5.67***	−5.81	−4.42**	1.14***	−0.33	0.37	0.82
85+	−19.21***	−13.95***	0.59	−22.85***	−20.25**	−34.60	1.90***	−11.10***	−0.13	−1.60
GMA score (baseline: Basal-risk)										
Low-risk	−3.44	−6.01	1.72**	−9.32	−10.99***	23.60	−1.49**	3.19**	2.74	7.78
Moderate-risk	−9.68***	−11.40**	1.88**	−27.28***	−23.59***	21.18	−1.55**	4.25**	2.46	4.74
High-risk	−19.88***	−18.25***	1.70	−55.58***	−45.74***	14.93	−1.68**	3.61**	2.40	4.16
Nationality (baseline: Spanish)										
27-EU and UK	5.31	0.24	1.62	−15.94**	4.50	−4.75	0.67	2.45	1.13	2.79
Northern Africa	20.05**	12.18**	11.57***	−12.15	3.07	13.15	1.45	1.83	0.19	−1.54
Caribbean and Central and South America	7.60	2.91	1.68	17.29**	6.17**	−11.19**	0.46	2.81	−0.48	−3.63
Rest of the World	−7.79	4.78	3.28**	−10.06	5.57	−2.30	1.61	2.33	−2.64**	2.63
Year in waiting list (baseline: 2015)										
2016	−3.67	0.11	−6.21	9.32	9.84**	−2.31	−0.31	−0.02	1.54**	0.36
2017	−15.62***	−27.14***	−11.87**	17.66**	23.60***	−6.03	0.82	0.04	0.69	−0.40
2018	−8.60	−18.45**	−16.01**	21.94**	39.27***	−14.39	0.31	−3.98	0.37	−1.02
2019	−0.84	−12.39	−8.27	35.89***	36.04***	−15.96**	0.71	−4.45	−0.94	−0.42
Month of hospital admission (baseline: Jan)										
Feb	4.17	−2.59	−5.80***	2.27	2.27	4.11	−4.06***	−2.05	−2.45***	−1.93
Mar	−0.22	−3.04	−9.31***	−6.68	−7.33	1.07	−3.30***	−7.96***	−1.08	−3.14
Apr	0.31	−0.56	−11.97***	−11.87***	−12.77***	1.47	−2.23***	−0.72	1.89**	0.51
May	−0.21	−3.75	−9.34***	−0.87	−10.74**	5.59	−2.57***	2.13	1.81**	0.95
Jun	6.67	−1.51	−5.15**	6.62	−8.10**	13.08**	−2.28***	0.59	0.22	0.12
Jul	1.77	−5.65	−2.85	12.07**	−14.41***	−1.54	−2.44***	1.11	−0.64	−0.01
Aug	14.61**	−1.50	9.78***	12.05	−6.59	2.36	0.26	7.00***	1.35	4.48**
Sep	34.91***	24.97***	22.61***	20.06***	7.98**	14.38**	3.34***	17.00***	3.97***	7.90***
Oct	36.52***	24.29***	21.70***	32.89***	18.98***	16.34**	−1.26	11.78***	2.87**	5.21**
Nov	31.43***	18.66***	18.59***	23.51***	9.05***	7.24	−2.71***	5.96**	1.29	0.22
Dec	27.38***	19.12***	13.30***	17.46**	4.69	−3.72	−3.13***	2.73	0.12	0.49
Observations	16,903	34,550	258,695	14,014	11,174	1758	17,762	4659	12,011	3255

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TABLE 4 (Continued)

	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
R^2	0.333	0.393	0.372	0.323	0.391	0.412	0.273	0.333	0.370	0.372
Mean	149.2	170.4	122.9	152.9	131.4	38.44	20.97	52.92	24.25	30.09

Note: Coefficients of Equation (2) for all hospital procedures. The unit of the coefficients is days. Waiting times, socioeconomic status, and control variables are defined in Section 4. Coefficients on procedure type, primary diagnosis, 'basic health area' of residence, and hospital fixed effects are not reported for the sake of brevity. Heteroskedastic-robust standard errors are clustered at the hospital level and are available upon request.

Parameters statistically significant at 1% (***), 5% (**), and 10% (*) levels are reported next to the coefficients.

TABLE 5 Results for waiting time inequalities by type of hospital.

	Hip replacement	Knee replacement	Cataract surgery	Prostatectomy	Hysterectomy	CABG	Breast cancer surgery	Prostate cancer surgery	Colorectal cancer surgery	Lung cancer surgery
Type of hospital (baseline: Public teaching hospital)										
Public non-teaching hospital	62.68***	112.17***	3.23	−98.92***	0.65	-	−14.22***	−24.01***	−11.36***	-
	(10.12)	(17.41)	(15.18)	(23.02)	(17.68)	-	(0.85)	(4.31)	(2.52)	-
Private not-for-profit teaching hospital	−12.23	−30.39**	−34.87**	−14.71	21.62	5.63	−0.49	−7.58**	−5.22***	−2.59
	(9.41)	(14.62)	(13.18)	(21.59)	(25.00)	(8.45)	(3.77)	(4.41)	(1.87)	(2.61)
Private not-for-profit non-teaching hospital	−23.90***	−31.48**	−31.15***	−44.29**	−20.36	-	−6.43**	−10.77**	−17.47***	-
	(7.94)	(12.58)	(7.50)	(17.08)	(20.84)	-	(2.93)	(3.95)	(1.91)	-
Observations	16,903	34,550	258,695	14,014	11,174	1758	17,762	4659	12,011	3255
R^2	0.279	0.303	0.325	0.272	0.348	0.390	0.200	0.268	0.334	0.336
Mean	149.2	170.4	122.9	152.9	131.4	38.44	20.97	52.92	24.25	30.09

Note: Coefficients of type of hospital for Equation (1) for all hospital procedures. The unit of the coefficients is days. Waiting times, socioeconomic status, and control variables are defined in Section 4. Coefficients on socioeconomic status and controls are not reported for the sake of brevity. Robust-heteroskedastic standard errors clustered at the hospital level are in parentheses.

Parameters statistically significant at 1% (***), 5% (**), and 10% (*) levels are reported next to the coefficients.

although waiting times are shorter, on average, for private not-for-profit hospitals across several surgeries, patients with differing SES do not benefit from such shorter waiting times in a systematic way.

6.4 | Socioeconomic inequalities in waiting times by gender

In this section, we explore whether the socioeconomic gradient in waiting times differs by gender. Table 6 provides the results of our preferred specification and shows that there is no systematic pattern. When comparing waiting times for very low and middle SES, we find that waiting times are more pronounced for women. For example, for hip replacement, women with middle SES wait 7.1 fewer days relative to low SES, while men 3.7 fewer days. The results are more pronounced for men when looking at high SES. For instance, for cataract surgery, men with high SES wait 24.7 fewer days relative to low SES, while women wait 14.1 fewer days.

6.5 | Reasons for exiting the waiting list

In Table 7, we show that the probability of voluntarily exiting the waiting list for patients with middle SES, relative to low SES, is higher for knee replacement by 1p.p. (with 11.5% of patients voluntarily exiting the waiting list), cataract surgery by 0.4p.p (with 3.8% of patients), prostatectomy by 1.2p.p. (with 7.2% of patients), and breast cancer surgery by 0.4p.p. (with 1%

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TABLE 6 Results for Waiting Time Inequalities by Socioeconomic Status and Gender (*within* hospitals).

	Hip replacement		Knee replacement		Cataract surgery		CABG		Colorectal cancer surgery		Lung cancer surgery	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Socioeconomic status (baseline: Low)												
Very low	5.47	5.92	0.48	5.84	−0.48	0.87	28.41*	16.96*	2.56**	1.52*	−2.75	0.07
	(3.59)	(4.37)	(2.45)	(6.40)	(0.69)	(1.29)	(12.39)	(6.60)	(1.22)	(0.89)	(4.29)	(1.85)
Middle	−7.11***	−3.70***	−0.77	−1.74	−3.21***	−1.70***	−3.13	1.80	−0.72	0.35	−1.65	0.64
	(2.20)	(1.34)	(1.31)	(1.65)	(0.60)	(0.51)	(7.73)	(4.34)	(0.57)	(0.32)	(1.08)	(0.61)
High	−30.55	−17.36	−21.56	−46.89***	−14.10**	−24.71***	-	−16.17	−5.02	−2.08	3.79	−1.10
	(20.01)	(11.36)	(14.57)	(15.75)	(5.89)	(2.92)	-	(10.60)	(4.60)	(2.43)	(4.57)	(3.94)
Observations	7734	9169	23,541	11,009	148,254	110,441	229	1529	4647	7364	908	2347
R^2	0.353	0.354	0.400	0.408	0.378	0.368	0.889	0.434	0.414	0.380	0.552	0.410
Mean	146.0	151.8	170.2	170.8	123.5	122.1	36.99	38.65	23.81	24.52	30.43	29.95

Note: Coefficients of Equation (2) for all hospital procedures by gender. The unit of the coefficients is days. Robust-heteroskedastic standard errors clustered at the hospital level are in parentheses. Waiting times, socioeconomic status, and control variables are defined in Section 4. Coefficients on control variables are not reported for the sake of brevity.

Parameters statistically significant at 1% (***), 5% (**), and 10% (*) levels are reported next to the coefficients.

of patients). Instead, patients with very low SES are 0.7p.p. more likely to voluntarily exit the waiting list for cataract surgery. These results suggest in general that patients with higher SES are more likely to voluntarily exit the waiting list, possibly due to patients obtaining care by another public or private provider. Patients with higher SES may be more effective in explaining their needs to clinicians who in turn can help them getting treatment in another hospital (public or private) with shorter waiting times.

For cataract surgery, the probability of having a surgery canceled for medical reasons is higher for patients with very low SES by 0.3p.p. (with 1.2% of patients having a surgery canceled) relative to low SES. It is lower by 0.5p.p. (with 1.9% of patients) for patients with middle SES undergoing a breast cancer surgery. These results are consistent with higher SES reducing the probability of having a surgery canceled. However, the effect is insignificant for most other procedures and SES groups, and for colorectal cancer surgery cancellations are higher for patients with high SES. One explanation for these findings is that patients with lower SES are more likely to have worse health and be at higher risk of complications if health deteriorates and thus have a higher likelihood of having a surgery canceled due to clinical reasons.

Relative to low SES, we also find that patients with middle SES have a lower probability of dying while waiting for hip replacement (by 0.2p.p.), cataract surgery (by 0.1p.p.), and hysterectomy (by 0.1p.p.), and patients with high SES have a lower probability of dying while waiting for cataract surgery (by 0.3p.p.). These results are consistent with people with lower SES having a higher mortality risk at any point in time irrespective of being on a waiting list, given that the health conditions associated with hip replacement and cataract surgery do not increase the mortality risk. The results may be also explained by patients in need of hip replacement and cataract surgery being generally older.

7 | CONCLUSION

This study has tested for the presence of socioeconomic inequalities in waiting times for several publicly-funded surgical procedures in Catalonia (Spain) in 2015–2019. The study highlights the presence of some inequalities in favor of patients with higher SES. These socioeconomic inequalities arise mostly *within* hospitals and are not explained by patient characteristics, location, or type of hospital. Our key findings are as follows. Relative to patients with low SES, patients with middle SES wait less by 4.8 days for hip replacement, 2.4 days for cataract surgery, 6.1 days for hysterectomy, and 0.5 days for female breast cancer surgery. We instead find no differences between low and middle SES for the remaining procedures (knee replacement, prostatectomy, CABG, and prostate, lung and colorectal cancer surgery).

We also find evidence that patients are prioritized on the list based on clinical need. For example, patients with complex needs (complexity score above 95th percentile of the population distribution) wait 18–19 days shorter for hip and knee replacement, and 46 and 56 days shorter for hysterectomy and prostatectomy, respectively. In relative terms, we conclude that the inequalities by SES are relatively small in comparison. However, we find that for one specific group, the patients with high SES

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TABLE 7 Results for reasons for exiting the waiting list.

	Patient voluntarily decides to exit the waiting list		Surgery canceled for medical reasons		Patient dies in the waiting list	
	Coef.	**SE**	**Coef.**	**Se**	**Coef.**	**Se**
Hip replacement						
Very low SES	0.011	(0.013)	0.003	(0.007)	0.003	(0.003)
Middle SES	0.004	(0.004)	−0.003	(0.003)	−0.002**	(0.001)
High SES	−0.007	(0.042)	0.055*	(0.030)	−0.002	(0.001)
Observations	18,317		17,463		16,967	
R^2	0.043		0.060		0.070	
Mean	0.077		0.032		0.004	
Knee replacement						
Very low SES	0.007	(0.011)	0.011	(0.007)	−0.000	(0.001)
Middle SES	0.010**	(0.004)	−0.000	(0.003)	−0.000	(0.001)
High SES	0.064	(0.056)	0.011	(0.025)	−0.001	(0.001)
Observations	39,021		35,862		34,628	
R^2	0.044		0.036		0.024	
Mean	0.115		0.037		0.002	
Cataract surgery						
Very low SES	0.007***	(0.002)	0.003**	(0.001)	0.000	(0.001)
Middle SES	0.004***	(0.001)	−0.001	(0.001)	−0.001**	(0.000)
High SES	0.016	(0.012)	−0.005	(0.004)	−0.003***	(0.000)
Observations	268,947		261,896		259,715	
R^2	0.016		0.022		0.012	
Mean	0.038		0.012		0.004	
Prostatectomy						
Very low SES	0.024	(0.016)	0.015	(0.012)	0.007	(0.007)
Middle SES	0.012***	(0.004)	0.003	(0.003)	0.001	(0.002)
High SES	0.009	(0.035)	0.001	(0.018)	0.001	(0.002)
Observations	15,104		14,608		14,121	
R^2	0.065		0.057		0.046	
Mean	0.072		0.041		0.008	
Hysterectomy						
Very low SES	0.001	(0.007)	0.011	(0.008)	0.000	(0.001)
Middle SES	0.002	(0.006)	0.002	(0.003)	−0.001**	(0.000)
High SES	−0.025	(0.048)	0.019	(0.035)	−0.003	(0.002)
Observations	11,907		11,421		11,184	
R^2	0.062		0.059		0.048	
Mean	0.062		0.022		0.001	
CABG						
Very low SES	0.030	(0.032)	0.006	(0.032)	−0.001	(0.002)
Middle SES	−0.007	(0.011)	0.001	(0.015)	0.002	(0.004)
High SES	−0.020	(0.034)	0.054	(0.039)	0.004	(0.006)
Observations	1806		1864		1764	
R^2	0.202		0.245		0.252	
Mean	0.027		0.057		0.003	

(Continues)

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TABLE 7 (Continued)

	Patient voluntarily decides to exit the waiting list		Surgery canceled for medical reasons		Patient dies in the waiting list	
	Coef.	**SE**	**Coef.**	**Se**	**Coef.**	**Se**
Female breast cancer surgery						
Very low SES	0.002	(0.004)	0.004	(0.005)	−0.000	(0.000)
Middle SES	0.004**	(0.002)	−0.005***	(0.002)	0.000	(0.000)
High SES	0.029	(0.028)	0.003	(0.023)	0.000	(0.000)
Observations	17,944		18,105		17,764	
R^2	0.043		0.039		0.030	
Mean	0.010		0.019		0.0001	
Prostate cancer surgery						
Very low SES	0.010	(0.025)	0.006	(0.026)	-	-
Middle SES	0.006	(0.006)	0.001	(0.006)	-	-
High SES	0.056*	(0.028)	0.015	(0.023)	-	-
Observations	4842		4772		-	
R^2	0.103		0.102		-	
Mean	0.038		0.024		-	
Colorectal cancer surgery						
Very low SES	0.002	(0.005)	−0.006	(0.006)	−0.000*	(0.000)
Middle SES	0.003*	(0.001)	0.002	(0.003)	−0.001*	(0.000)
High SES	0.010	(0.021)	0.094**	(0.042)	−0.001	(0.000)
Observations	12,124		12,334		12,018	
R^2	0.062		0.053		0.028	
Mean	0.009		0.026		0.001	
Lung cancer surgery						
Very low SES	0.022*	(0.011)	0.028	(0.027)	−0.004	(0.003)
Middle SES	−0.000	(0.004)	0.003	(0.007)	−0.001	(0.001)
High SES	−0.007	(0.006)	−0.060*	(0.028)	−0.001	(0.001)
Observations	3289		3364		3257	
R^2	0.131		0.123		0.210	
Mean	0.010		0.032		0.001	

Note: Coefficients of Equation (2) for all hospital procedures using a dummy variable equal to one if a patient exits the waiting list for another reason than having a surgery, and zero otherwise. The unit of the coefficients is percentage points. Robust-heteroskedastic standard errors clustered at the hospital level are in parentheses. Dependent variables, socioeconomic status, and control variables are defined in Section 4. Coefficients on control variables are not reported for the sake of brevity. Parameters statistically significant at 1% (***), 5% (**), and 10% (*) levels are reported next to the coefficients.

(with an income above €100,000) inequalities in waiting times are more substantive, over 20 days difference for hip and knee replacement, and cataract surgery, relative to low SES. The number of patients with high SES is however small.

There are different possible explanations for our findings. Patients with higher SES may be better at articulating their needs and making a case for being given higher priority in the waiting list. They may be better at keeping up with the processes of the health systems and have more flexibility in their schedule, which in turn could affect the probability of missing appointments and attending the scheduled hospital admission reducing thus the duration of their waiting time. Moreover, patients with higher SES could get ahead in the queue by putting pressure to the provider (e.g., through frequent phone calls) or through informal channels (e.g., knowing someone working at the hospital). They are also likely to be better informed of their rights and, potentially, take legal actions if delays become significant. Moreover, healthcare professionals might have more affinities and empathy with patients with higher SES.

Our findings also show that patients with middle SES relative to low SES are more likely to voluntarily exit the waiting list for knee replacement, cataract surgery, prostatectomy, and breast cancer surgery. These results suggest that patients with

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higher SES are more likely to exit the waiting list in the public sector to seek medical treatment in another public or private hospital. We find that patients with higher SES have a lower likelihood of having a surgery canceled for medical reasons for cataract surgery and breast cancer surgery, suggesting that poorer patients have worse health. These results suggest that patients with lower SES have poorer access to health care, not only in the form of longer waiting time, but also in terms of higher cancellations.

Our study has some limitations. First, we cannot observe SES directly, but only indirectly on the basis of co-payment levels for medicines which depend on patient's income or benefits, and the variable with high SES only involves a small number of individuals. Second, although we have controlled for a number of patient characteristics, we cannot exclude that unobserved dimensions of patient complexity remain. Last, we have focused on inpatient waiting time, and patients may experience delays in other segments of the patient pathway.

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CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are non-public anonymized patient-level data and are available from the Agency for Health Quality and Assessment of Catalonia (Agència de Qualitat i Avaluació Sanitàries de Catalunya), within the framework of the PADRIS Program (Programa PADRIS), at https://aquas.gencat.cat/ca/ambits/analitica-dades/padris/. Restrictions apply to the availability of these data, which were used under license for this study.

ORIGINAL PUBLICATION

The authors declare that the manuscript contains original unpublished work and is not being submitted for publication elsewhere at the same time. The paper was covered in the media (El País, EFE and La Vanguardia) with a short piece of news after the presentation at the 41st Spanish Health Economics Conference (2022).

ETHICS STATEMENT

This study used anonymized patient-level data provided by the Agency for Health Quality and Assessment of Catalonia (Agència de Qualitat i Avaluació Sanitàries de Catalunya), within the framework of the PADRIS Program (Programa PADRIS). Thus, ethics approval is implicit within the PADRIS program.

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ENDNOTES

[1] In 2019, the ratio of the highest over the lowest quintile of the income distribution was 5.4 in Catalonia, while it was 5.0 and 5.9 in the European Union and Spain, respectively (Statistical Institute of Catalonia, 2022).

[2] In 2018, health expenditure per capita in US dollars was 6187 in Norway and 5447 in Sweden, while it was 3323 in Spain (OECD, 2019).

[3] In 2018, the ratio of the highest over the lowest decile of the income distribution was 4.8 in Spain, while it was 3.1 and 3.3 in Norway and Sweden, respectively (OECD, 2022).

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[4] Civil servants legally have the right to choose between NHS coverage and a private health insurance.

[5] In 2017, 16.3% of the Spanish population were covered by civil servants' or private health insurance (National Statistics Institute, 2018). In Catalonia, the percentage rises to 23.6% in 2017 (National Statistics Institute, 2018).

[6] "Basic health areas" are small areas (374 in Catalonia) covering a population with a minimum of 5000 and a maximum of 25,000 individuals (Pelegrí Viaña, 2011).

[7] The percentage volume of all planned surgeries performed by privately-owned for-profit hospitals in Catalonia was 28.1% in 2017 (Department of Health, 2019).

[8] The 14 procedures are cataract surgery, hip replacement, knee replacement, varicose vein, inguinal and femoral hernia, cholecystectomy, septoplasty, arthroscopy, vasectomy, prostatectomy, carpal tunnel surgery, amygdalotomy and/or adenoidectomy, circumcision, and hysterectomy (DOGC, 2002).

[9] If the maximum time guarantee is exceeded, patients can decide to either stay on the waiting list or choose another hospital (most likely private) outside the public network of providers but with an established contract with the public funder (DOGC, 2002). Under the second option, the funder has to either transfer the patient to one of its hospitals and guarantee a maximum waiting time, which is the same as the hospital chosen by the patient, or authorize that the patient receives surgery in the chosen hospital at the expense of the public funder (DOGC, 2002). If the funder does not have a solution in 30 days, the patient is treated by the chosen hospital, but publicly-funded (DOGC, 2002).

[10] Hysterectomy (prostatectomy) does not include patients with cancer or carcinoma in situ of uterus and ovary (prostate).

[11] Colorectal cancer includes colon and rectum cancers. Lung cancer includes trachea, bronchus, and lung cancers.

[12] Tables A2 and A3 in Appendix A report the codes considered using the International Classification of Diseases, ninth Edition (ICD-9-CM) and 10th Edition (ICD-10-PCS/ICD-10-CM). In Catalonia, hospitals reported procedure and diagnosis codes using the ICD-9-CM until 2018. From 2018, hospitals can report their data using interchangeably the ICD-9-CM or ICD-10-PCS/ICD-10-CM. We mapped codes in the ICD-10-PCS/ICD-10-CM to the ICD-9-CM following the official mapping by the Ministry of Health, Consumer Affairs and Social Welfare (https://eciemaps.mscbs.gob.es/ecieMaps/browser/indexMapping.html).

[13] See https://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_PROC.

[14] We focus on these three reasons because the patient exits completely the waiting list (different from a postponed surgery) and they are the most common and policy relevant. Other reasons include patient asks for or accepts a delay, surgery is postponed for medical reasons, patient is transferred to another provider, patient cannot be contacted, patient does not accept the date of surgery, incorrect register to the waiting list, patient with surgery in another provider, duplicate in another provider, specialist considers that the surgery is not appropriate, patient is not present at the date of surgery, change of insurance, emergency surgery, and non-authorized patient.

[15] Married people out of the labor force are assigned to the SES level of their partner. Widowed people out of the labor force receive a non-contributory pension and are assigned to very low SES.

[16] Although unobserved by healthcare providers and clinicians, GMA scores might be endogenous if high complexity is given to a patient that has been given high priority while on the waiting list. Table B12 in Appendix B excludes patient's GMA score to rule out endogeneity concerns about this control variable. The results are robust to this omission.

[17] Tables A4 and A5 in Appendix A report ICD-9-CM codes and descriptions of the categories employed as primary diagnosis and procedure type by procedure.

[18] See https://www.idescat.cat/poblacioestrangera/?geo=cat&nac=a&b=11&m=m for the classification of countries in each subgroup.

[19] The number of clusters ranges from 40 to 55, except for CABG (six clusters) and lung cancer surgery (13 clusters). Due to few clusters in CABG and lung cancer surgery (Cameron et al., 2008), we calculate wild-bootstrapped cluster standard errors with 9999 repetitions and find that the significance of the results is robust (available upon request).

[20] We prefer not to transform w_{ijt} as then β_y can be interpreted as days. The distributions of waiting times by surgery are not highly right-skewed (see Figure B1 in Appendix B) and the distributions of the residuals of regressing w_{ijt} on SES and controls follow a normal distribution (see Figure B2 in Appendix B). Moreover, we do not need to assume that the error term in Equation (1) follows a normal distribution so that β_y are normally distributed. Instead, β_y follow asymptotically a normal distribution by the central limit theorem and relying on a large sample (Wooldridge, 2010).

[21] β_y might be biased if patients with higher SES expecting a long waiting time opt for private treatment. Tables B1 and B2 in Appendix B present the proportion of patients by SES with low (below the median) and high (above the median) waiting times and show that patients with very low, low, and middle SES are equally distributed across low and high waiting times. Instead, the results for patients with high SES should be taken with more caution since the proportion of patients with high SES is slightly larger in low waiting times.

[22] Similarly, the proportion of patients waiting more than the maximum time guarantee of 180 days is 32.9%, 39.5%, and 18.7% for hip replacement, knee replacement, and cataract surgery, respectively. Instead, 9.8% of patients that underwent a CABG exceed the maximum time guarantee of 90 days and 35.2% of patients with prostate cancer surgery exceed 60 days. 5.7%, 11.5%, and 20% of patients with female breast, colorectal, and lung cancer surgery, respectively, have a waiting time longer than 45 days.

[23] Table B3 in Appendix B reports the proportion of patients by SES attending each type of hospital (whether public, private, or teaching) and shows that the distribution of patients is similar across types of hospital. That is, poorer/richer patients are not more likely to be treated in certain types of hospital. Similar descriptive statistics are found for each hospital procedure and are available upon request.

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[24] In Appendix B, we show that the main results are generally robust when waiting times are measured in logs in Tables B4 and B5, and when we estimate a Generalized Linear Model (GLM) in Table B6. In Table B4, we measure waiting times in logs and retransform the coefficients in days using $\left(exp^{\beta_y}-1\right)\times \text{waiting times mean}$. The results show that socioeconomic inequalities are in general larger in magnitude than those in Table 4, except for patients with very low SES undergoing a colorectal cancer surgery. Moreover, the difference in waiting times for patients with very low SES relative to low SES undergoing a hip replacement is no longer statistically significant, while socioeconomic inequalities in waiting times for patients with high SES relative to low SES undergoing a prostatectomy, hysterectomy, and a colorectal cancer surgery become statistically significant. In Table B5, we measure waiting times in logs and apply the Duan's smearing estimator for the retransformation of logs of waiting times to days. Then, Table B5 reports the mean of the fitted waiting times in days after applying the Duan's smearing estimator by SES (in parentheses) and the difference in days of subtracting the mean of patients with low SES (baseline category) to that of very low, middle and high SES. The results are similar to those in Table B4. Table B6 reports the coefficients and marginal effects in days of estimating a GLM with Gaussian distribution and log link function. Again, the results are in line with those in Table 4 in terms of statistical significance and magnitude, except for patients with high SES (middle SES) relative to low SES undergoing a CABG (prostate cancer surgery) whose coefficient becomes statistically significant.

[25] For example, patients older than 85 years for hip and knee replacement wait, respectively, 19.2 and 13.9 fewer days than patients in the 66–75 reference group, though these very elderly patients represent only 3% and 1.4% of patients treated. For cataract surgery, patients younger than 56 years old wait less by at least 19.4 days. For prostatectomy, patients who are older than 85 years wait at least 22.9 days less. For hysterectomy, waiting times monotonically decrease with age. Waiting time for breast cancer surgery increases with age, while it decreases with age for prostate cancer surgery. For lung cancer surgery, patients aged 46–55 and 56–65 wait less than patients aged 66–75.

[26] Patients within age bands might be treated differently in the waiting list, which might bias the results if age is correlated with SES. We estimate the results with 3-year age bands in Table B8 in Appendix B and show that the results are robust to this alternative specification. We also interact age bands with gender in Table B9 in Appendix B and show that the results are similar to our main results.

[27] Table 4 also shows seasonal effects, that is, patients treated in the first semester of the year wait less than those treated in the second semester. These seasonal effects are mainly due to the backlog of patients accumulated during the summer holidays (July-August) caused by lower activity while staff is on leave, which translates into a longer waiting time for those on the list. Also, some hospitals reach the maximum planned activity that has been agreed with the funder before the end of the financial year. This implies that payment is reduced for additional volume, which also creates a financial incentive to reduce the volume of elective procedures in the second semester.

[28] In Table B11 in Appendix B, we investigate whether waiting time inequalities by SES are more pronounced at the upper end of the waiting time distribution in relation to the maximum time guarantee. We therefore replicate the analysis in Table 4 but use as dependent variable a dummy variable equal to one if patient's waiting time is greater than the maximum time guarantee. The results are generally in line with those reported in Table 4 but display less statistical significance.

[29] We have four hospital types: public teaching hospital (baseline), public non-teaching hospital, private not-for-profit teaching hospital, and private not-for-profit non-teaching hospital. There is only one public non-teaching hospital. We therefore comment mostly on whether private not-for-profit teaching and non-teaching hospitals have shorter waiting times than public teaching hospitals.

[30] Relative to public teaching hospitals, private not-for-profit non-teaching hospitals have shorter waiting times for hip (23.9 fewer days or 16% less) and knee replacement (31.5 days shorter or 18.5% less), cataract surgery (31.2 fewer days or 25.4% less), prostatectomy (44.3 fewer days or 29% less), breast cancer surgery (6.4 fewer days or 30.5% less), prostate cancer surgery (10.8 fewer days or 20.4% less), and colorectal cancer surgery (17.5 fewer days or 72% less).

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