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Title

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Running title

Waiting times and socioeconomic status

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Conflicts of interest

None of the authors have any conflicts of interest to declare.

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ABSTRACT

In publicly funded health systems, waiting times act as a rationing mechanism that should be based on need rather than socioeconomic status. However, several studies suggest that individuals with higher socioeconomic status wait less. Using individual-level data from administrative registers, we estimate and explain socioeconomic inequalities in access to publicly funded care for seven planned hospital procedures in Denmark. For each procedure, we first estimate the association between patients' waiting time for health care and their socioeconomic status as measured by income and education, controlling for patient severity. Then, we investigate how much of the association remains after controlling for i) other individual characteristics (patients' family status, labour market status, and country of origin) that may be correlated with income and education, ii) possible selection due to patients' use of a waiting time guarantee, and iii) hospital factors which allow us to disentangle whether inequalities in waiting times arise *across* hospitals or *within* the hospital. Only for a few procedures we find inequalities in waiting times related to income and education. These inequalities can be explained mostly by geographical and institutional factors across hospitals. But we also find inequalities for some procedures in relation to non-Western immigrants within hospitals.

JEL codes: I11, I14

Keywords: Waiting time, income, education, equity, access to care, planned treatment.

1. INTRODUCTION

Waiting times are a major health policy concern across OECD countries (Siciliani, Borowitz, & Moran, 2013). With public insurance and limited or no co-payments, an imbalance may arise between the demand for and the supply of health services, leading to long waiting times and waiting lists that act as a form of non-price rationing (Martin & Smith, 1999). The rationale for rationing publicly funded health care by waiting time, rather than price, is that access should not depend on the ability to pay. Instead, in the presence of co-payments, individuals with higher income will be able to more easily afford health care contributing to inequalities in access.

Under rationing by waiting, patients in equal need are supposed to wait their turn irrespective of their ability to pay or other characteristics such as family background, employment status, and ethnicity. Despite this rationale, several studies using large samples from administrative data find waiting time inequalities in access to health care by socioeconomic status in publicly funded health systems (Landi, Ivaldi, & Testi, 2018; Siciliani, 2016). Inequalities have been found across several non-emergency hospital procedures, such as cataract surgery, hip and knee replacement, coronary bypass, and across countries, such as England (Cooper, McGuire, Jones, & Le Grand, 2009; Laudicella, Siciliani, & Cookson, 2012; Moscelli, Siciliani, Gutacker, & Cookson, 2018), Norway (Kaarboe & Carlsen, 2014; Monstad, Engesæter, & Espehaug, 2014), Australia (Johar, Jones, & Savage, 2013; Sharma, Siciliani, & Harris, 2013), and Sweden (Smirthwaite, Lundström, Wijma, Lykke, & Swahnberg, 2016; Tinghög, Andersson, Tinghög, & Lyttkens, 2014).

This study aims to assess for Denmark whether socioeconomic factors, such as income and education, affect waiting times for several common non-emergency hospital procedures, namely hernia surgery, gallstone surgery, hip replacement, knee replacement, cataract surgery, prostatectomy, and hysterectomy. Denmark has an income inequality amongst the lowest in the world (OECD, 2019a) and a publicly funded health system with an ambition to provide equal access to care that is free at the point of delivery (Olejaz et al., 2012). However, studies find that Denmark has socioeconomic inequalities in health that are amongst the highest of the Nordic countries and that these inequalities have been increasing over time (Brønnum-Hansen & Baadsgaard, 2008; Christiansen et al., 2018)[1]. Combined with the availability of detailed individual-level administrative data, the country thus represents an interesting case study to investigate socioeconomic inequalities in one key dimension of responsiveness of health care, namely how long patients wait.

Our first aim is to estimate the association between patients' waiting time for health care and their socioeconomic status, controlling for patient severity, with socioeconomic status being measured by income and education. Next, we investigate whether income and education is still associated with waiting time after controlling for three different groups of determinants: i) other patient characteristics, i.e. patients' family status (marital status, number of children, and whether they have an adult child), labour market status (employed, self-employed, unemployed, or retired) which can also be thought as a dimension of socioeconomic status, and country of origin (Dane, non-Western immigrant, or Western immigrant), ii) possible selection due to patients' use of a waiting time guarantee, and iii) hospital factors (fixed effects) which allow to disentangle whether inequalities in waiting times arise *across* hospitals or *within* the hospital.

Our key findings are as follows. Only for a few publicly funded procedures there exist inequalities in waiting times related to income and education. More precisely, we find a negative association between patients' waiting time and their income and education for two out of seven hospital procedures, controlling for patient severity. For cataract surgery, the waiting time is shorter (9-18%, 8-17 days) for patients in the highest (8^{th}-10^{th}) income deciles compared to patients in the lowest (1^{st}) income decile. Patients also wait less (3-16%, 3-15 days) for cataract surgery if their highest level of completed education exceeds primary school. For hernia surgery, male patients in some of the highest (5^{th}-8^{th}) income deciles wait less (6-7%, 4-5 days) compared to male patients in the lowest (1^{st}) income decile. We find that the identified income inequalities for men operated for hernia is explained by other patient characteristics. Men wait longer for a hernia operation if they

[1] Studies argue that this finding could be due to how standard bivariate measures of health inequality respond to changes in the income distribution. Thus, an increase in measured health inequality might be caused by reduced income inequality (Brekke & Kverndokk, 2012).

are retired (3%, 2 days), single (4%, 3 days), divorced (3%, 2 days), or if they are non-Western immigrants (20%, 13 days). The last result also extends to other procedures. For around half of the seven procedures we find that non-Western immigrants wait 11-26% (8-18 days) longer for treatment than Danish patients.

In Denmark, patients who receive a referral to a hospital are covered by a waiting time guarantee. If patients wait longer than the maximum waiting time period, they have a legal right to an extended choice of provider, i.e. they can receive care from private providers with no additional expenses. Patients' use of this guarantee is limited for most of the selected procedures, with the exception of cataract surgery and prostatectomy. For these two procedures, access to private providers may affect patients' waiting time. We find that there is a gradient in using the guarantee in favour of patients with the highest education and income level. We also find inequalities in waiting time related to income and education for cataract surgery at both public and private providers after taking this self-selection into account. Women in the highest income deciles (7th-10th) wait less (6-23%, 5-21 days) for cataract surgery at both public and private providers. They also wait less (15%, 14 days) at private providers if they hold a graduate degree. Similarly, men in the highest income deciles (7th-10th) wait less (16-20%, 9-11 days) for cataract surgery at private providers.

The identified inequalities in waiting time may be due to inequalities that arise *across* hospitals (due to certain patient groups being located near hospitals with shorter waits) or *within* hospitals. For all procedures, we find no association between patients' income and education and their waiting time within hospitals. This finding indicates that the identified inequalities are due to differences in waiting times *across* hospitals. However, for around half of the procedures we find that non-Western immigrants wait longer *within* hospitals.

We make several contributions to the literature. Firstly, this study is the first using administrative data to focus on Denmark, adding to the international literature on inequality in waiting times across different health systems and institutional settings. Similar to England, Norway and Sweden, Denmark has a National Health Service with a relatively small private sector treating publicly funded patients. Differently from the majority of studies on other countries, we find little waiting time inequalities in socioeconomic status within hospitals.

Secondly, differently from the studies from England and Australia, and in line with studies from Norway and Sweden (Monstad et al., 2014; Smirthwaite et al., 2016; Tinghög et al., 2014), we are able to measure income and education at the individual level removing possible aggregation biases. We also include a rich set of covariates that relate to family status (e.g. whether single, divorced, widow, or married), labour market status (e.g. whether employed, self-employed, unemployed, or retired), and country of origin (e.g. whether a Dane, non-Western immigrant, or Western immigrant). We include these variables because they could either affect waiting times directly or indirectly explain waiting time inequalities in socioeconomic status measured by income and education.

Thirdly, this study is the first to decompose waiting times between *active* waiting, i.e. waiting time due to provider delay, and *passive* waiting, i.e. waiting time due to the patient, for example if the patient cancels an appointment or needs more time to consider whether to be treated, which may be correlated with socioeconomic status. Moreover, waiting time is measured comprehensively following the patient journey from the date a hospital registers the initial referral, most often from a general practitioner (but also from a private specialist or another hospital ward), to treatment. It therefore includes also the waiting time for specialist visits or diagnostic examinations at the hospital, removing possible concerns that some waiting time inequalities may arise before the specialist adds the patient to the list to treatment. In England, a similar waiting time measure is available, known as "Referral to Treatment" waiting time (NHS England, 2015). Until 2015 the measure also included the waiting time when patients could "pause or suspend the clock", which is similar to the passive waiting time used in Denmark. However, as far as the authors are aware, these data are not linked to the Hospital Episodes Statistics, and therefore there is no link to socioeconomic status even at a small area level. Therefore, the measure of waiting time used in this study is thus more nuanced than that used in previous studies from England (Cooper et al., 2009; Laudicella et al., 2012) and Australia (Johar et al., 2013; Sharma et al., 2013), where only the inpatient waiting time is recorded from the specialist's addition to the list to treatment.

Fourthly, we are able to measure waiting times for both public and private providers. While public hospitals treat only publicly funded patients, private providers treat both publicly and privately funded patients in Denmark. We are therefore able to assess whether there is inequality in waiting time for publicly funded patients when treated by a public or private provider, respectively. Due to data limitations, this level of granularity is not covered in previous studies.

The paper is organised as follows. Section 2 introduces the institutional setting. Section 3 presents the data. Section 4 and 5 describe the methods and results, respectively. Section 6 discusses the results along with policy recommendations and suggestions for future research.

2. INSTITUTIONAL SETTING

The Danish health care system is primarily funded by general taxation and offers universal coverage to all registered residents. The system is regulated by the state and operated by the regions and municipalities. The five regions own and manage public hospitals as well as provide primary care through contracts with self-employed providers in the private practice sector. The 98 municipalities are responsible for prevention, health promotion, rehabilitation, treatment of citizens with alcohol and drug abuse, and the provision of primary health care and long-term care to its citizens (Mossialos, 2017).

Patients' first point of contact is typically their GPs who also act as gatekeepers to specialist care.[2] Following the GPs' referral, patients can freely choose among publicly funded providers. Patients can receive specialist care both from specialists working in a private practice and in publicly owned hospitals. Patients in need of acute care will be referred to a joint acute ward[3], while elective patients will be referred to a specific hospital department for diagnosis and/or treatment. Most hospital contacts are to outpatient wards, which provide diagnostic tests before treatment and follow-up consultations after treatment (Olejaz et al., 2012). As distances are short and public transportation is well-functioning, patients can easily access different health care providers (Olejaz et al., 2012).

Patients who receive a referral to a hospital are covered by a waiting time guarantee. If patients wait longer than the maximum waiting time period (details are provided in subsection 2.1), they have a legal right to an extended choice of provider. "The extended choice" allows patients to receive publicly funded care at a private hospital in Denmark or abroad. Under the waiting time guarantees patients can only choose private hospitals or clinics that the Danish Regions (the association of regions) have a collective agreement with. In addition, the waiting time at the private hospitals and clinics cannot exceed the waiting time at public hospitals, and the patients must pay themselves for the transportation to the provider (Danish Ministry of Health, 2016). Geographically, private hospitals and clinics are concentrated in larger cities and mostly provide elective (planned, non-emergency) surgeries (Kiil, 2011). Only around 2-3% of publicly funded somatic patients[4] receive care at private hospitals under the waiting time guarantees (Danish Ministry of Health, 2018).

Patients may also receive care at a private hospital or clinic without making use of the waiting time guarantees. If the regions are facing capacity constraints, they may choose to contract with private hospitals and clinics to deliver services at a more favourable price than under the waiting time guarantees (Skovgaard & Kjellberg, 2016). Around 1-2% of publicly funded somatic patients receive treatment at private hospitals or clinics under these contracts (Danish Ministry of Health, 2018). Patients may also choose to pay for hospital treatment out of pocket or by using their private health insurance if they hold one. Around one third of the Danish population hold a supplementary health insurance, which covers expanded access to private providers. As private employers use these insurance policies as fringe benefits, a majority of the covered patients are active on the labour market (Mossialos, 2017). However, only around 3-4% of all somatic patients pay for hospital treatment out of pocket or through their private insurance (Danish Health Data Authority, 2018b).

[2] Access to emergency wards, dentists, chiropractors, ear, nose and throat specialists or ophthalmologists does not require referral from a GP (Olejaz et al., 2012).

[3] A joint acute ward receives acute patients suffering from all kinds of health problems.

[4] Somatic patients are characterised by being treated for a physical illness, i.e. non-mental health-related illness.

2.1 Waiting time guarantees for somatic patients at hospitals

There are waiting time guarantees for patients who are referred to a public hospital for a diagnostic assessment or somatic treatment. The referral can be made by a GP, a private practice specialist, another hospital ward (including emergency unit) or hospital. The hospital that receives the initial referral has eight days to inform the patient whether the waiting time guarantee can be fulfilled as well as provide information about the patient's right to choose another provider and how to receive additional information (Danish Ministry of Health, 2013).[5]

In the years prior to 2013, patients could choose private providers if they were expected to wait longer than one month to start diagnostic assessment or treatment from the referral was received at the hospital.[6] An exception was made for patients with life-threatening diseases, i.e. cancer and certain ischemic diseases, whose maximum waiting guarantee is shorter (Christiansen & Bech, 2013).

In 2013 the waiting time guarantees were modified. First, patients had the right to have their diagnostic assessment at the hospital *completed* within one month. If this was not medically feasible, then they should receive a plan for further diagnostic assessment. Second, the waiting time guarantee for hospital treatment was differentiated based on the severity of the patients' (both within and across) illnesses. Patients with a low severity could wait up to two months for treatment, whereas patients with a high severity should wait no longer than one month (Danish Ministry of Health, 2013).

The regional councils classified the severity of illness based on the following factors: 1) Whether the prospect of recovery would worsen significantly if the treatment was postponed, 2) whether the illness resulted in daily and severe pain requiring strong painkillers, which the treatment could relieve or eliminate, and 3) whether the illness resulted in severe functional impairments[7], which the treatment could significantly improve or normalise. The final decision on the individual patient's severity of illness was based on a medical assessment made by the hospital, which should include the patient's viewpoint (Danish Ministry of Health, 2013). Consequently, the classification could differ among patients with the same illness.

In 2016 the differentiation of waiting time for hospital treatment was abolished. This implied that all somatic patients, independently of the severity of their illnesses, had a right to receive hospital treatment within one month from the referral was received at the hospital (Danish Ministry of Health, 2016).

3. DATA

We use administrative data from the Danish National Patient Registry and socioeconomic registries at Statistics Denmark from 2013 to 2015.[8] The Danish National Patient Registry includes information on all somatic outpatient and inpatient hospital contacts at both public and private providers and on admissions to emergency departments. Each record includes information on the date of admission and discharge, the referrer, the type of contact, procedures, diagnoses, and waiting time.

[5] The hospital sends a letter, which states the date and place for the diagnostic assessment or treatment. The letter also includes information on: 1) patients' right to a free and extended free choice of provider, 2) whether the wait is within the limit of the waiting time guarantees, 3) how to get information on relevant providers' waiting times and their number of performed diagnostic assessments and treatments, 4) patients' responsibility for the transportation under the free or extended choice of provider, 5) who to contact (opening hours and telephone number) for information and/or a referral to another provider, and 6) patients' right to complain.

[6] The waiting period did not include pre-examination periods lasting less than 14 days, or periods where the treatment must be postponed due to patients' health condition or own wishes.

[7] They assessed whether patients could perform general and necessary personal tasks in everyday life, personal hygiene, food intake, movement, and lacked the ability to maintain employment.

[8] In 2016 the Capital Region of Denmark implemented a new data system "Sundhedsplatformen", which may have affected the registration of waiting times in the following years. Also, the waiting time guarantees were changed up to 2013 and again after 2015 (see section 2.1). We therefore restrict our analysis period to 2013-2015, which represents the period we can observe with good data quality for the whole country under the same policy regime.

Our sample includes the following elective surgical procedures at Danish hospitals: hernia surgery, gallstone surgery, hip replacement, knee replacement, cataract surgery, prostatectomy, and hysterectomy[9]. These procedures are a part of the Danish Regions' waiting times statistics (Danish Health Data Authority, 2018a) as well as the OECD's Health Statistics (OECD, 2019b). According to the Danish Regions, five of the chosen procedures (hernia, gallstone, hip replacement, knee replacement, and cataract) are among the 9 most prevalent in 2015 (if we disregard endoscopies). The remaining two procedures (prostatectomy and hysterectomy) are of interest because they involve only men or women.

Using data on hospital contacts from the Danish National Patient Registry, we employ the Danish Health Data Authority's algorithm for waiting times to construct the sample. The algorithm connects contacts (and thereby waiting times) related to the same course of treatment (Statens Serum Institut, 2015). The sample includes patients over the age of 18 years who are alive the entire year of analysis and have undergone one of the selected procedures during 2013 to 2015[10]. As the institutional setting differs depending on the funder (see section 2), we focus on publicly funded procedures. Due to data limitations, we are only able to identify publicly funded procedures at private providers if they are performed under the waiting time guarantee. Among the publicly funded procedures performed at private providers, we therefore only include procedures performed under the guarantee. However, the excluded (publicly and privately funded) procedures at private providers only account for around 1% of our sample, and therefore are unlikely to affect our results.

Table 1 shows the number of publicly funded hospital procedures each year between 2013 and 2015. The share of procedures performed at a private provider under the waiting time guarantee varies significantly across procedures. Only around 1% of knee replacements are performed at a private provider, whereas this is around 18-29% for cataract surgeries (see table 2). The private providers include both private hospitals and private clinics, which have an agreement with the regions under the waiting time guarantee. Henceforth, we denote these private providers as "private hospitals". Table 3 reports the number of private and public hospitals performing the procedures each year of analysis.

Table 1: The number of publicly funded hospital procedures by gender from 2013 to 2015

	Men			Women		
	2013	2014	2015	2013	2014	2015
Hernia	8,364	7,813	7,759	2,090	1,892	1,972
Gallstone	1,207	1,139	1,203	3,291	3,087	3,231
Hip replacement	2,670	2,638	2,512	3,626	3,634	3,612
Knee replacement	2,365	2,341	2,159	3,738	3,494	3,208
Cataract	10,538	9,054	9,333	14,457	12,435	12,782
Prostatectomy	1,858	1,779	1,406	0	0	0
Hysterectomy	0	0	0	2,943	2,934	2,627

Note: The data include publicly funded procedures at public hospitals as well as at private hospitals and clinics under the waiting time guarantee.

Table 2: The proportion of publicly funded procedures performed by a private provider under the waiting time guarantee by gender from 2013 to 2015

	Men			Women		
	2013	2014	2015	2013	2014	2015
Hernia	0.056	0.045	0.064	0.058	0.048	0.072
Gallstone	0.022	0.032	0.030	0.034	0.045	0.046
Hip replacement	0.013	0.015	0.015	0.007	0.012	0.013
Knee replacement	0.006	0.017	0.008	0.009	0.014	0.013
Cataract	0.262	0.186	0.201	0.286	0.184	0.215
Prostatectomy	0.298	0.246	0.122	0	0	0

[9] Excluding cases of uterine cancer or ovarian cancer.

[10] The patients' waiting periods may start before January 2013, but their procedures must have been performed within January 2013 to December 2015.

Hysterectomy	0	0	0	0.014	0.009	0.017	

Note: The data include publicly funded procedures at public hospitals as well as at private hospitals and clinics under the waiting time guarantee.

Table 3: The number of public and private providers by gender from 2013 to 2015

		Men			Women		
Procedure	Provider	2013	2014	2015	2013	2014	2015
Cataract	Public	15	12	13	16	12	13
Cataract	Private	28	11	10	32	12	10
Gallstone	Public	25	20	20	25	20	21
Gallstone	Private	4	6	6	10	8	6
Hernia	Public	27	22	21	25	21	23
Hernia	Private	14	10	10	7	8	10
Hip replacement	Public	22	19	19	22	19	19
Hip replacement	Private	5	8	6	7	3	5
Hysterectomy	Public	0	0	0	21	19	18
Hysterectomy	Private	0	0	0	9	6	5
Knee replacement	Public	22	19	17	24	19	16
Knee replacement	Private	4	8	3	4	8	4
Prostatectomy	Public	19	15	16	0	0	0
Prostatectomy	Private	12	10	8	0	0	0

Note: The data include publicly funded procedures at public hospitals as well as at private hospitals and clinics under the waiting time guarantee.

Our dependent variable is the waiting time for a hospital surgical procedure. Waiting time is defined by the Danish Health Data Authority as the number of days from the date a hospital registers the initial referral from either a general practitioner, private specialist or another hospital ward to the date the procedure is performed (Statens Serum Institut, 2015). If the procedure is performed several times during the same course of treatment, time until the first procedure determines the waiting time. The waiting time is attributed to the hospital that has the first contact with the patient during the course of treatment.[11] Only 0.01% of the selected procedures are not performed at the hospital with the first contact.

The hospitals record patients' waiting time. They distinguish between active and passive waiting time as defined by the Danish Health Data Authority. The authority defines *active* waiting time as the time the patient waits before receiving either a diagnosis, treatment, or assistance. *Passive* waiting time refers to delays that occur if the patient cancels the appointment, takes time considering whether to be treated, has a scheduled check-up, has a different condition that needs to be treated first, or is undergoing examinations or treatment (Statens Serum Institut, 2015). Therefore, the passive waiting time is attributed to the patient, implying that the provider is not responsible for it and plays a passive role.[12] To avoid issues with outliers in our analyses, we truncate the sample at the 1st and 99th percentile of both active and passive waiting times.

To measure each patient's socioeconomic status, we use information on their highest level of completed education[13] and household disposable income. We denote these two measures our "core socioeconomic variables". We also include information on the patient's labour market status, which may also be considered a measure of socioeconomic status (Saegert et al., 2007). Education is categorised as primary and lower secondary education (education level 1), upper secondary and vocational education (education level 2),

[11] This rule also applies to cases where the initial referral was first sent to a hospital, which had no contact with the patient, but that registered the initial referral.

[12] The Danish Health Data Authority's official statistics is based only on active waiting times (Danish Health Data Authority, 2018a).

[13] The information on education is incomplete for around 2% of the observations. These observations are primarily linked to patients over the age of 90 and immigrants.

undergraduate education (education level 3), and graduate education (education level 4) (Danish Ministry of Higher Education and Science, 2018). Household disposable income is adjusted for the size of the family and number of children in accordance with OECD's equivalence scale (OECD, 2013). We group the income by the deciles of the annual income distribution of the entire Danish population.

The labour market status is categorised as employed, self-employed, unemployed or retired. We measure the patients' family status by their marital status, number of children, and whether they have an adult child (age 18 or older). We also include patients' country of origin[14] and whether they are either Danes or immigrants[15]. We control for the patients' severity of illness using information on their age and comorbidities measured by the Elixhauser-van Walraven Comorbidity Index[16] (van Walraven, Austin, Jennings, Quan, & Forster, 2009).

4. METHODS

We estimate the degree of socioeconomic inequality in waiting time for a set of high-volume hospital procedures in Denmark. We estimate the following Equation 1 separately for men and women, in line with previous studies that find differences in waiting times across gender (e.g. Monstad et al. (2014)). In our first specification, we model the waiting time w_{it} for publicly funded patient i, whether in a public or private hospital, in year t as

$$\ln(w_{it}) = \boldsymbol{s}'_{it}\beta_s + \boldsymbol{y}'_{it}\beta_y + \boldsymbol{d}_t + \varepsilon_{it}\,, \qquad (1)$$

where $\boldsymbol{s}_{it}$ is a vector of variables measuring the patient's severity of illness, $\boldsymbol{y}_{it}$ is a vector of variables measuring patient's socioeconomic status, $\boldsymbol{d}_t$ is a vector of year effects, and ε_{it} is an idiosyncratic error term. As waiting times are highly skewed to the right, we apply a logarithm transformation of the dependent variable.[17]

Our estimate of interest is $\hat{\beta}_y$, which measures the association between patients' waiting time and their socioeconomic status. If $\hat{\beta}_y \neq 0$, then this is suggestive evidence of inequality in waiting times across individuals with differing socioeconomic status. If $\hat{\beta}_y < 0$, then patients with higher socioeconomic status are associated with a shorter wait.

During our period of analysis, waiting time guarantees were differentiated based on severity of patients' illnesses (see section 2.1). Thus, we expect more severely ill patients to experience shorter waiting times, i.e. $\hat{\beta}_s < 0$. As the patients' severity of illness may be correlated with their socioeconomic status, with more severe patients more likely to be prioritised and wait less, it is important to control for their health state (to avoid downward bias in the gradient). We measure the patients' severity of illness, $\boldsymbol{s}_{it}$, as a vector of their age and comorbidities measured by the Elixhauser-van Walraven Comorbidity Index.

Our *basic* model includes only two core socioeconomic variables, income and education. As waiting times may be correlated with other patient characteristics, which are also correlated with income and education, we include in our *extended* model also the patients' labour market status, family status, and immigration status.

[14] Country of origin is defined as either a Western country or non-Western country. Following Statistics Denmark, Western countries include the 28 EU-countries as well as Andorra, Iceland, Liechtenstein, Monaco, Norway, San Marino, Switzerland, Vatican City, Canada, USA, Australia, and New Zealand.

[15] Statistics Denmark defines an immigrant based on the following two criteria: 1) the patient is born outside of Denmark and 2) the patient's parents do not hold a Danish citizenship and are born outside of Denmark. A descendant differs from an immigrant only by being born in Denmark. As the number of immigrants is small for some procedures, we include both immigrants and descendants (as defined by Statistics Denmark) in our "immigrant" category. Our findings are, however, robust to excluding descendants from our estimations.

[16] The index is calculated based on ICD10-codes registered in the Danish National Patient Registry from 2004 to 2016. This register is based on all hospital contacts and allows for registration of multiple diagnoses (ICD10-codes). Diagnoses only registered in primary care are not included.

[17] We solve transformation issues due to some patients having less than one day waiting time (in days) by assigning 1 to patients who waited less than a day, 2 to patients who waited less than two days, etc.

The extended model therefore shows how much of the association remains between waiting time and income/education after controlling for labour market status, family background and immigration status.[18]

Our dependent variable measures the patients' total experienced waiting time for publicly funded procedures. This waiting time may be attributed to factors under both the hospital's and the patient's control. The data from the Danish National Patient Registry enables us to distinguish between active and passive waiting time; the former being under hospital control while the latter being under patient control (see section 3). Therefore, in an appendix we also estimate the *extended* model using only the active waiting time for hospital care.

We estimate our models using OLS with robust standard errors. For the estimations to yield a causal relation between socioeconomic status and waiting time, the assumption of conditional mean independence would need to hold for the socioeconomic status. As we do not include measures of all factors (e.g. patients' and their family members' health literacy) that may be associated with both waiting time and socioeconomic status, we do not interpret our estimates as causal. However, we minimise this concern by including a rich set of control variables.

4.1 The waiting time guarantee: Right to private treatment

Publicly funded hospital treatment is primarily performed in public hospitals. Some elective procedures may, however, also be performed at private hospitals. Our sample includes publicly funded procedures performed in private hospitals under the waiting time guarantee (see section 2.1). Patients with a higher socioeconomic status may find it easier to navigate the health care system and thereby use the guarantee more frequently. One could therefore hypothesize that socioeconomic inequalities in waiting times may be driven by selection into using the guarantee. In addition, socioeconomic inequalities in waiting times may not be present to the same degree at the two different types of providers (public versus private), independently of this selection.

Table 2 shows that the share of publicly funded procedures performed under the guarantee varies across both gender and procedures. Private hospitals perform only 0-7% of hernia surgeries, gallstone surgeries, hip replacements, knee replacements, and hysterectomies. As the private market for these procedures is very limited, we do not expect the private market to impact waiting times. However, private hospitals perform around 18-30% of the cataract surgeries and prostatectomies. For these two procedures it is important to account for potential self-selection into using the guarantee as well as to investigate the socioeconomic gradient in waiting time for the two different types of providers. We therefore estimate separate endogenous switching regression models for cataract surgery and prostatectomy.

The switching regression models include a correction term to control for self-selection due to patients using the extended choice of provider under the waiting time guarantees (private hospitals). Following Moscelli et al. (2018) and Toomet and Henningsen (2008), we estimate the models in two steps. The first step estimates a probit to model whether patient i in year t took advantage of the extended provider choice under the waiting time guarantee (the selection equation):

$$g_{it} = \mathbf{I}\left(\boldsymbol{s}'_{it}\gamma_s + \boldsymbol{z}'_{it}\gamma_z + \boldsymbol{y}'_{it}\gamma_y + \boldsymbol{d}_t + \upsilon_{it} > 0\right), \qquad (2)$$

where g_{it} is a dummy equal to one if the patient is treated under the waiting time guarantee (at a private provider) and zero otherwise. Patients use of the guarantee is potentially affected by the same factors affecting their waiting time. We therefore control for the same covariates as in the extended model. If $\hat{\gamma}_y > 0$ it suggests that patients with higher socioeconomic status are more likely to exercise the guarantee.

[18] As some of the covariates may be correlated, we investigate the degree of multicollinearity in the extended model. We find no issues with multicollinearity (see section 5.2.1).

To avoid issues with collinearity when estimating the waiting time equations (in the second step), we include an instrument, z_{it}, in the selection equation (Newey, 1999). The instrument measures the difference in the travel time by car between the closest public hospital and the closest private hospital for a given procedure from the centre of patients' municipality of residence (see Figure 4 for a map of the 98 municipalities). Our instrument exploits these travel time differences as an exogenous source of variation in the propensity to make use of the extended choice of provider.

Our instrument, z_{it}, must satisfy three conditions to produce consistent estimates. First, travel time should affect patients' choice of hospital (the relevance condition). A longer travel time makes access to the public hospital more difficult relative to the private hospital, and therefore increases the likelihood of the patient making use of the guarantee (go private), $\hat{\gamma}_z > 0$. Second, we assume that those whose choice is impacted by travel time are all impacted in the same way (the monotonicity condition). Third, our instrument should be conditionally uncorrelated with the error term in the waiting time equations (the excludability condition). Following previous waiting time studies (e.g. Moscelli et al. (2018)), we therefore assume that the difference in travel time between the nearest hospitals does not directly impact the waiting time for hospital care, when we control for the other covariates. We also assume that patients' choice of residential area is not based on the expected waiting time for a given hospital procedure.

The second step estimates separate OLS models of the waiting time for the subgroup of patients using the guarantee (private hospitals) ($g_{it} = 1$) and not using the guarantee (public hospitals) (g_{it}=0), respectively:

$$\ln(w_{it1}) = \boldsymbol{s}'_{it1}\beta_{s1} + \boldsymbol{y}'_{it1}\beta_{y1} + \boldsymbol{d}_{t1} + \varrho_1\sigma_1\lambda_1(\hat{p}) + u_{it1} \text{ if } g_{it} = 1 \qquad (3)$$

$$\ln(w_{it0}) = \boldsymbol{s}'_{it0}\beta_{s0} + \boldsymbol{y}'_{it0}\beta_{y0} + \boldsymbol{d}_{t0} + \varrho_0\sigma_0\lambda_0(\hat{p}) + u_{it0} \text{ if } g_{it} = 0 \qquad (4)$$

The waiting time equations include the same covariates as in the extended model plus a selection correction term, i.e. $\lambda_1(\hat{p})$ and $\lambda_0(\hat{p})$. Thus, if $\hat{\beta}_y \neq 0$, then this is suggestive evidence of inequality in waiting times across individuals with differing socioeconomic status.

The selection correction terms are based on the estimated propensity scores, $\hat{p}$, from the first step (the selection equation), i.e. $\lambda_1(\hat{p}) = \phi[\Phi^{-1}(\hat{p})]/[1-\hat{p}]$ and $\lambda_0(\hat{p}) = -\phi[\Phi^{-1}(\hat{p})]/[\hat{p}]$. The parameters σ_1 and σ_0 represent the standard deviations of the error terms for the waiting time equations. The parameters ϱ_1 and ϱ_0 measure the correlation between the error term from the selection equation, v_{it}, and the error term from the waiting time equations, u_{it1} and u_{it0}. If $\varrho_1, \varrho_0 \neq 0$ it indicates that there is self-selection into using the guarantee (Toomet & Henningsen, 2008).

4.2 Waiting time within hospitals

Patients' waiting time may differ across hospitals. This variation may be due to both supply-side factors, e.g., number of physicians, number of hospital beds, and efficiency, and demand-side factors, e.g., the share of elderly patients (Siciliani, 2016). To explore whether the association between waiting times and socioeconomic status is explained by these factors, we include hospital fixed effects, $\boldsymbol{d_j}$, in the models. We therefore model waiting time for patient i in hospital j in year t as:

$$\ln(w_{ijt}) = \boldsymbol{s}'_{ijt}\beta_s + \boldsymbol{y}'_{ijt}\beta_y + \boldsymbol{d}_j + \boldsymbol{d}_t + \varepsilon_{ijt}\,, \qquad (5)$$

where $\boldsymbol{d}_j$ is a vector of hospital fixed effects. As we control for hospital characteristics, the estimates in this model should be interpreted as explaining within-hospital variation in waiting time, whereas the estimates in the previous models (without hospital fixed effects) explains variation in waiting time both across and within hospitals.

5. RESULTS

5.1 Descriptive statistics

Table 4 presents an overview of our dependent and explanatory variables for publicly funded procedures by gender. The sample includes 76,138 and 85,053 courses of treatment for men and women, respectively. The average waiting time for these treatments is 74 days for men and 76 days for women. Around 9-10 days of this waiting time is passive, i.e. delays due to the patient, whereas the remaining waiting time is active, i.e. delays due to the provider. Figure 1 illustrates the distribution of total and active waiting time overall as well as by procedure.

Around 12% of the patients make use of the waiting time guarantee, which entails receiving treatment at a private provider. The average waiting time at private providers under the guarantee is 36-37 days less than at public providers. According to the guarantee, patients may use a private provider when their expected waiting time exceeds the maximum acceptable wait (see section 2.1). The experienced active waiting time is on average 64-68 days, which is more than twice as long as the maximum acceptable wait for treatment of high severity illnesses (30 days) and slightly longer than the maximum acceptable wait for treatment of low severity illnesses (60 days). One explanation for the longer experienced active waiting time is that it also includes time spent on diagnostic assessments, which is not part of the treatment guarantee[19].

One possible determinant of using the waiting time guarantee is travel time to the provider. The average travel time by car to the nearest public provider is 21 minutes shorter than to the nearest private provider for the selected procedures.

We measure patients' severity of illnesses by their age and comorbidities. The average age of the patients is 67 for men and 66 for women, which is above the official retirement age of 65 years. We measure the patients' comorbidities using the Elixhauser-van Walraven Comorbidity Index. The average comorbidity score is 2.6 for men and 1.8 for women in our sample.

Our core socioeconomic variables are income and education, which we include in both the basic and extended models. The distribution of the patients' household disposable income is similar to that of the general population. The only exception being the lowest income decile, which only represents 4% of our sample. The patients' level of education is only slightly lower than that of the general adult population. Around 80% of the patients completed no more than the upper secondary and vocational level of education; the same holds for 73% of the general adult population.

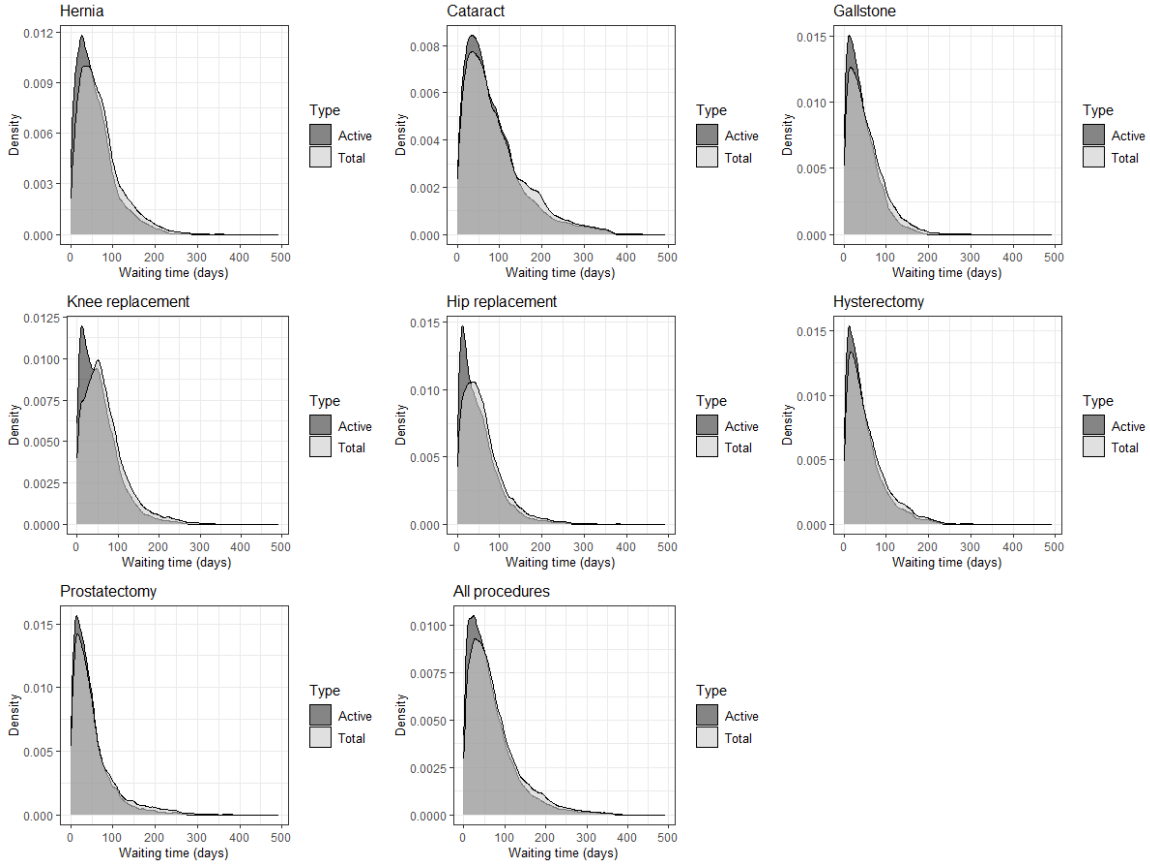
The extended model also includes measures of the patients' labour market status, family status, and immigration status. The median patient is retired and married with two children, of which at least one is an adult. Around 94% of the patients originate from Denmark. Among the immigrants around half descend from a non-Western country.

[19] Instead there is a separate guarantee for diagnostic assessment at the hospital. Patients have the right to have completed their diagnostic assessment within one month (see section 2.1).

Table 4: Descriptive statistics for all publicly funded procedures by gender

	Men (N=76,138)					Women (N=85,053)				
Variable	Mean	St. Dev.	Min	Median	Max	Mean	St. Dev.	Min	Median	Max
Total waiting time (days)	73.66	59.79	0	58	483	76.49	63.70	0	60	485
Public providers	77.98	60.81	0	63	483	81.00	65.09	0	64	485
Private providers	41.75	38.79	0	32	324	43.67	39.05	0	34	338
Active waiting time (days)	64.15	54.46	0	50	359	67.50	59.01	0	52	365
Passive waiting time (days)	9.51	26.67	0	0	262	9.00	25.05	0	0	237
Waiting time guarantee	0.12	0.32				0.12	0.33			
Income										
Decile 1	0.04	0.19				0.04	0.19			
Decile 2	0.11	0.32				0.14	0.35			
Decile 3	0.16	0.37				0.20	0.40			
Decile 4	0.13	0.34				0.14	0.35			
Decile 5	0.11	0.31				0.11	0.31			
Decile 6	0.10	0.29				0.09	0.28			
Decile 7	0.09	0.28				0.08	0.26			
Decile 8	0.08	0.28				0.07	0.26			
Decile 9	0.09	0.29				0.07	0.25			
Decile 10	0.09	0.29				0.07	0.25			
Education										
Level 1	0.30	0.46				0.40	0.49			
Level 2	0.50	0.50				0.39	0.49			
Level 3	0.11	0.31				0.16	0.36			
Level 4	0.07	0.25				0.03	0.18			
Missing	0.02	0.16				0.02	0.15			
Family status										
Married	0.66	0.47				0.50	0.50			
Single	0.12	0.33				0.10	0.29			
Widow	0.09	0.29				0.25	0.43			
Divorced	0.12	0.33				0.16	0.37			
Number of children	1.82	1.20				1.87	1.14			
Adult child	0.76	0.42				0.78	0.41			
Labour market status										
Employed	0.26	0.44				0.23	0.42			
Self-employed	0.03	0.17				0.01	0.10			
Retired	0.66	0.48				0.70	0.46			
Unemployed	0.05	0.22				0.06	0.25			
Immigrant status										
Dane	0.94	0.24				0.93	0.25			
Western immigrant	0.03	0.16				0.03	0.17			
Non-Western immigrant	0.03	0.18				0.04	0.19			
Severity of illness										
Age	66.63	13.54	18	69	103	66.15	14.95	18	69	107
Comorbidities	2.62	4.94	−11	0	45	1.75	4.58	−16	0	47
Travel time by car (minutes)										
Nearest public providers	22.94	16.02	2	19	381	22.61	15.77	2	19	381
Nearest private providers	43.88	44.75	1	33	388	44.34	42.92	1	33	388

Figure 1: The distribution of total and active waiting time (days) overall and by procedure



Note: Total waiting time includes both active and passive waiting time. "All procedures" combines the waiting time for the 7 procedures: hernia, cataract, gallstone, knee replacement, hip replacement, hysterectomy, and prostatectomy.

5.2 Regression results: Assessing the socioeconomic gradient in waiting time

We now turn to the regressions results to investigate socioeconomic inequalities in waiting time for publicly funded patients for the seven planned hospital procedures. Appendix A1 and A2 show the results obtained by estimating the basic model separately for men and women, which includes two core socioeconomic variables, income and education, and controls for the patients' severity of illness. Patients' severity of illness is measured by their age and comorbidities. As expected, for most procedures the older age groups experience a shorter wait. However, patients' comorbidities do not seem to be a strong determinant of their waiting time.

Figures 2 and 3 provide the estimates for the two core socioeconomic variables, income and education. There is a socioeconomic gradient in waiting time for cataract and hernia surgery, but no gradient for gallstone surgery, hip replacement, knee replacement, prostatectomy, and hysterectomy. The waiting time is shorter for men (10-13%[20], 9-12 days[21]) and women (9-18%, 8-17 days) in the highest (8^{th}-10^{th}) income deciles undergoing cataract surgery as well as men in the higher (5^{th}-8^{th}) income deciles for hernia surgery (6-7%, 4-5 days) compared to patients in the lowest (1^{st}) income decile.[22] We also find that men (3-11%, 3-10 days) and women (9-16%, 8-15 days) wait less for cataract surgery if their highest level of completed education exceeds primary school. Meanwhile, contrary to our expectations, we find a longer wait for men (3-9%, 2-6 days) and women (5-19%, 4-15 days) undergoing hernia surgery and for women undergoing a hysterectomy (6-15%, 3-8 days) if their highest level of completed education exceeds primary school. The longer wait for women with higher education can, however, be explained by factors unrelated to the provider, i.e. the *passive* waiting time (see appendix A5-A6).

5.2.1 Controlling for other patient characteristics: Labour market status, family factors and country of origin

The identified socioeconomic inequalities in waiting time may be attributed to other patient characteristics that are correlated with income and education as well as waiting time. In an effort to more precisely measure socioeconomic inequalities, we estimate an extended model. The extended model includes the patients' labour market status, family status, and country of origin. As the explanatory variables may be correlated, we investigate the degree of multicollinearity. We calculate the adjusted generalised variance inflation factors (GVIF to the power of 1/2df) to account for several of the variables being categorical, e.g. income, education, occupation (Fox & Monette, 1992). According to appendix A7-A8 the highest adjusted GVIF is less than 2, indicating no issues with multicollinearity in the extended model.

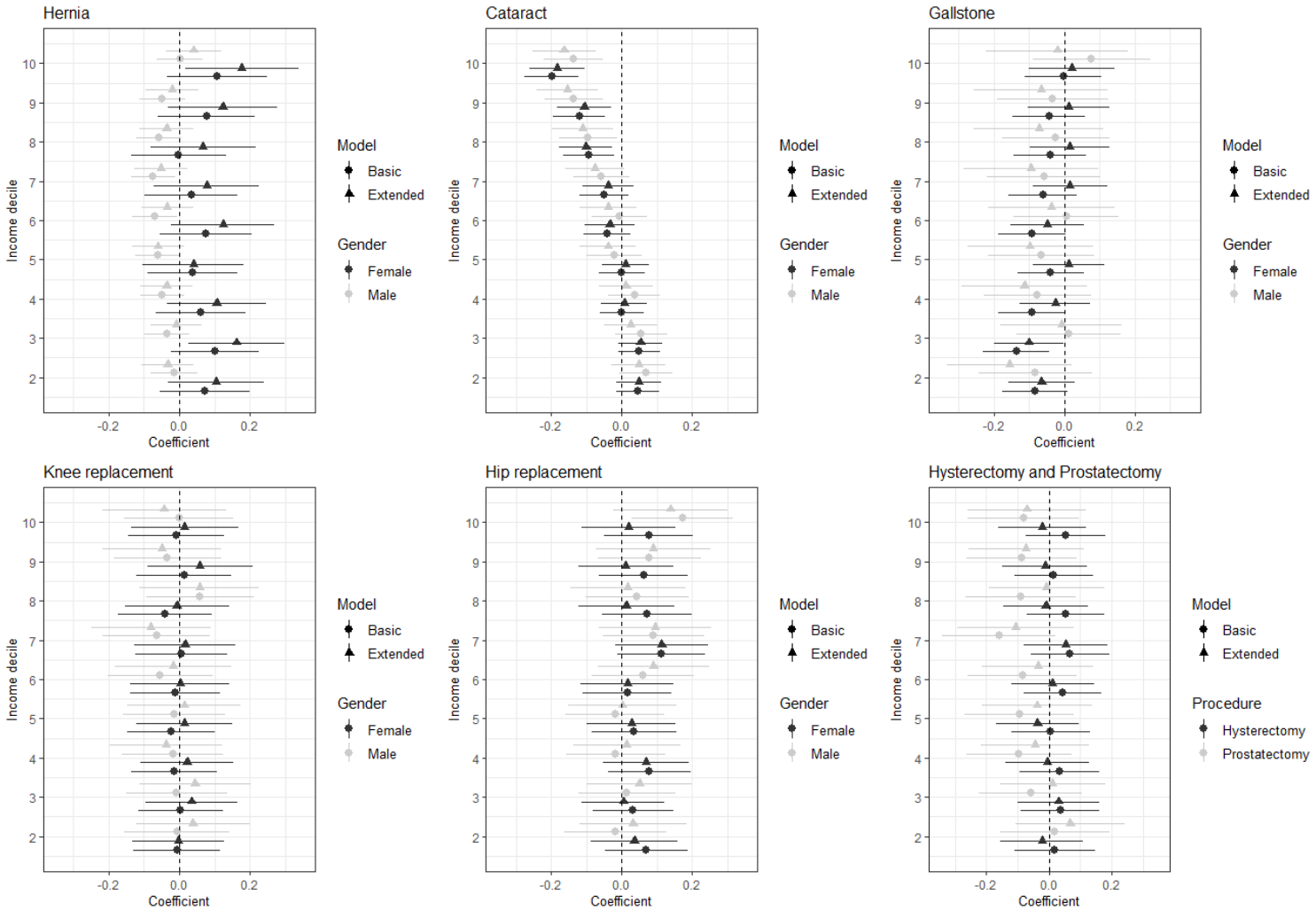
Appendix A9 and A10 present the results and figure 2 and 3 visualise the estimates for the two core socioeconomic variables income and education in the extended model. For both men and women undergoing cataract surgery the inequalities related to income and education remain the same when we include the additional covariates. For men undergoing hernia surgery there is no longer an association between income and waiting time. However, they wait longer if they are retired (3%, 2 days), single (4%, 3 days), divorced (3%, 2 days), or non-Western immigrants (20%, 13 days). The findings for non-Western immigrants apply across procedures and gender. For around half of the procedures, we find that non-Western immigrants on average wait 11-26% (8-18 days) longer than patients of Danish origin. Appendix A11-A12 show that our findings hold when we consider only the *active* waiting time, i.e. wait due to the provider only.

[20] We use the coefficient estimates, β, to calculate the marginal percentage change in waiting time as $\%\Delta w = 100 \cdot (e^{\beta} - 1)$.

[21] We calculate the change in days at the mean waiting time for a given procedure and gender. Appendix A3 reports the mean waiting times.

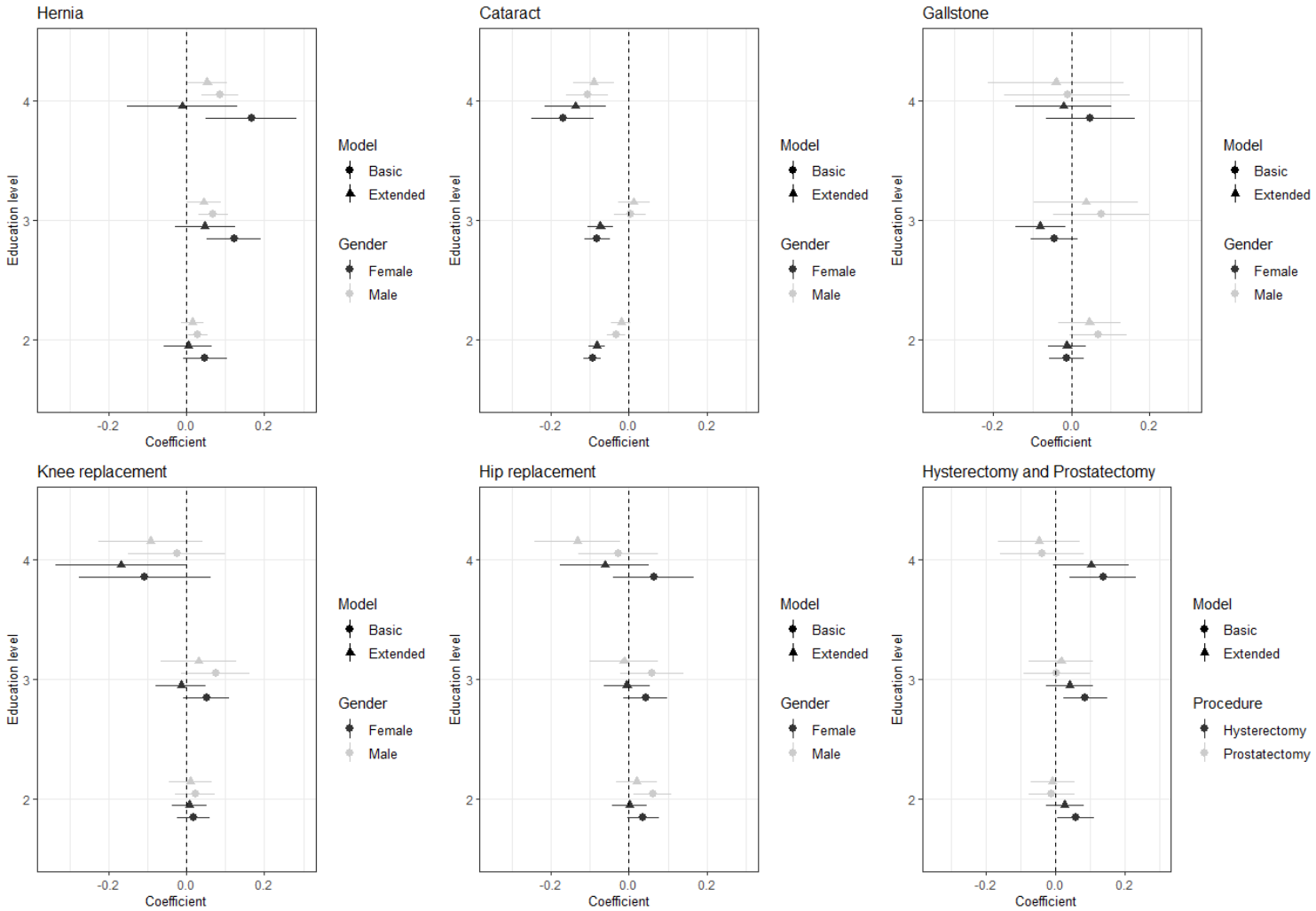
[22] The advantage of modelling income as deciles is that it allows for a non-linear relationship between income and log waiting time. As a robustness check, we estimate the model using the natural logarithm of income instead. This approach allows us to interpret the estimates as income elasticities of waiting time. However, it imposes a logarithmic relationship between income and the log of waiting time, which may not hold. Appendix A4 reports the income elasticities of waiting time. According to these results the income elasticity is -0.13 for both men and women undergoing cataract surgery, whereas the income elasticity for men undergoing hernia surgery is not statistically significant.

Figure 2: Estimates for the association between income and total waiting time for the basic and extended model across procedures and by gender



Note: The markers indicate the estimates, whereas the horizontal lines indicate their 95%-confidence intervals.

Figure 3: Estimates for the association between education and total waiting time for the basic and extended model across procedures and by gender



Note: The markers indicate the point estimates, whereas the horizontal lines indicate their 95%-confidence intervals.

5.2.2 The waiting time guarantee: Right to private treatment

The average waiting time at private providers under the guarantee is 36-37 days less than at public providers (see table 4). Patients may therefore wait substantially less if they make use of the extended choice of provider under the waiting time guarantee. Private providers perform around 18-30% of publicly funded cataract surgeries and prostatectomies (see table 2). For these two procedures we therefore investigate whether there is a socioeconomic gradient in using the guarantee and in waiting times conditional on receiving treatment by a public or a private provider. Tables 5 and 6 present the results for both a probit model of using the guarantee (the selection equation) and the *extended* model when accounting for self-selection in using the guarantee (the two waiting time equations for public and private providers).

The estimates from the selection equations show that there is a socioeconomic gradient in using the guarantee across the two procedures. As expected, patients with a higher income and educational attainment make use of the guarantee more often. The estimates from the waiting time equations show some socioeconomic inequalities in waiting times at both public and private providers after taking self-selection into account. Similar to the estimates from the extended model (with no selection correction), we only find a socioeconomic gradient in waiting times for patients undergoing cataract surgery. We find that men in the highest income deciles (7^{th}-10th) wait less (16-20%, 9-11 days) for cataract surgery at *private* providers, but no socioeconomic inequality in waiting time at *public* providers. On the other hand, women in the highest income deciles (7th-10th) wait less (6-23%, 5-21 days) for cataract surgery at both *public and private* providers. They also wait less (15%, 14 days) at *private* providers if they hold a graduate degree.[23]

Our results show that there exist socioeconomic inequalities in waiting times for patients undergoing cataract surgery at both public and private providers as well as inequality in the use of the private providers. In Denmark private providers are concentrated in larger cities (Kiil, 2011). Also, public contracts with private providers are made at the regional level. During our study period the North Denmark Region had difficulties reaching an agreement on the provision of cataract surgeries with private providers.[24] Interestingly, we find that the income inequalities for cataract surgery in the extended model[25] disappears when we control for region fixed effects (see appendix A17-A18). This finding indicates that the inequalities in waiting time for cataract surgery may be driven by both geographical and institutional factors.

5.2.3 Waiting times within hospitals

The waiting time inequalities identified so far may be due to inequalities that arise *across* hospitals (due to certain patient groups being located near hospitals with shorter waits) or *within* hospitals. Figure 4 shows the geographical variation in patients' waiting times, socioeconomic status (measured by income), and needs (measured by comorbidities and age). To identify inequalities within hospitals, Appendix A19 and A20 report the results for the *extended* model including hospital fixed effects. Across gender and procedures, we find no association between the patients' income and education and their waiting time within hospitals, which in turn suggests that most of inequalities are due to differences in waiting times across hospitals. However, for around half of the procedures, we still find that non-Western immigrants on average experience a longer wait (13-19%, 7-13 days) compared to patients of Danish origin. These findings hold when we consider only the *active* waiting time within hospitals (see appendix A21-A22).

[23] The estimates for the selection correction terms are statistically significant, confirming the presence of self-selection into using the waiting time guarantee. We investigate the importance of this selection for our findings by comparing the selection corrected estimates with the ones obtained from OLS regressions of private and public hospitals' waiting times without the correction terms. Appendix A15-A16 show that not accounting for self-selection has negligible effect (magnitude and statistical significance) on the socioeconomic estimates for total waiting times at both public and private providers.

[24] This issue was described in the news outlet Danmarks Radio, 2015 (title: "Grå stær: Betal 8.000 for en operation eller vent op til et år" ["Cataract: Pay 8000 for an operation or wait up to a year"]). Available: https://www.dr.dk/nyheder/regionale/nordjylland/graa-staer-betal-8000-en-operation-eller-vent-op-til-et-aar [Accessed September 2, 2019].

[25] As the number of patients treated at private providers is small in some regions, it was not possible to estimate switching regression models with regional fixed effects. However, appendix A15-A16 show that not accounting for self-selection has negligible effect (magnitude and statistical significance) on the socioeconomic estimates for the extended model without fixed effects for patients undergoing cataract surgery at public and private providers, respectively.

Table 5a: Extended model controlling for selection due to use of the extended choice of provider under the waiting time guarantees (men)

	Cataract			
	Dependent variable:	*Dependent variable:*		
	Use of the guarantee	log total waiting time (days)		
		Public hospitals (selection correction)	Private hospitals (selection correction)	All hospitals (no selection correction)
	(1)	(2)	(3)	(4)
Income2	0.035 (0.063)	0.025 (0.037)	0.222** (0.086)	0.05 (0.04)
Income3	0.017 (0.062)	0.009 (0.036)	0.198** (0.085)	0.04 (0.04)
Income4	0.129** (0.064)	0.030 (0.038)	0.185** (0.087)	0.01 (0.04)
Income5	0.132** (0.066)	−0.034 (0.039)	0.174* (0.089)	−0.04 (0.04)
Income6	0.214*** (0.067)	0.014 (0.040)	0.177** (0.090)	−0.03 (0.04)
Income7	0.267*** (0.068)	−0.012 (0.041)	0.082 (0.091)	−0.08* (0.04)
Income8	0.297*** (0.069)	−0.016 (0.043)	0.018 (0.093)	−0.12*** (0.04)
Income9	0.296*** (0.070)	−0.086** (0.043)	0.081 (0.093)	−0.16*** (0.04)
Income10	0.292*** (0.071)	−0.043 (0.044)	0.016 (0.094)	−0.17*** (0.05)
Education2	0.123*** (0.021)	0.004 (0.013)	0.004 (0.028)	−0.03** (0.01)
Education3	0.076** (0.034)	0.036* (0.021)	−0.013 (0.043)	0.01 (0.02)
Education 4	0.139*** (0.040)	−0.031 (0.028)	−0.025 (0.050)	−0.09*** (0.03)
Education(.)	−0.098* (0.059)	−0.030 (0.035)	−0.039 (0.080)	−0.004 (0.04)
Self-employed	−0.115* (0.068)	−0.006 (0.042)	−0.127 (0.088)	0.002 (0.04)
Retired	−0.012 (0.037)	0.029 (0.024)	−0.094** (0.047)	−0.01 (0.02)
Unemployed	0.157** (0.067)	0.030 (0.042)	−0.076 (0.087)	−0.04 (0.04)
Single	−0.156*** (0.041)	0.005 (0.024)	0.037 (0.056)	0.04* (0.02)
Widow	−0.005 (0.028)	0.009 (0.017)	−0.008 (0.037)	0.005 (0.02)
Divorced	0.092*** (0.028)	−0.002 (0.018)	−0.015 (0.036)	−0.04** (0.02)
Number of children	−0.044*** (0.010)	−0.010* (0.006)	0.042*** (0.013)	0.02*** (0.01)
Adult child	0.093*** (0.034)	0.002 (0.021)	−0.013 (0.044)	−0.02 (0.02)
Western immigrant	0.187*** (0.057)	−0.059 (0.038)	−0.120* (0.069)	−0.14*** (0.04)
Non-Western immigrant	0.221*** (0.050)	0.132*** (0.034)	−0.199*** (0.063)	−0.04 (0.04)
Comorbidities	−0.005*** (0.002)	−0.002** (0.001)	0.003 (0.002)	0.0003 (0.001)
Distance instrument	0.020*** (0.0004)			
σ_0		0.835*** (0.004)		
ϱ_0		0.091*** (0.032)		
σ_1			0.927*** (0.009)	
ϱ_1			−0.092* (0.050)	
Constant	−1.586*** (0.221)	4.003*** (0.091)	3.922*** (0.399)	4.03*** (0.10)
Observations	28,925	22,603	6,322	28,925

Note: The estimates in columns (1-3) are based on an endogenous switching regression model for using the extended choice of provider under the waiting time guarantees, i.e. being treated at a private hospital. The estimates in column (4) are from the extended model (reported in table 7), i.e. they are based on a OLS regression without the selection correction. The models include year fixed effects and controls for age using the age bands 18-35, 36-45, 56-65, 66-75, 76-85 and 85+. Standard errors in parentheses.

* p < 0.10, ** p < 0.05, *** p < 0.01.

Table 5b: Extended model controlling for selection due to use of the extended choice of provider under the waiting time guarantees (men)

	Prostatectomy			
	Dependent variable:	*Dependent variable:*		
	Use of the guarantee	log total waiting time (days)		
		Public hospitals (selection correction)	Private hospitals (selection correction)	All hospitals (no selection correction)
	(1)	(2)	(3)	(4)
Income2	−0.054 (0.142)	−0.028 (0.119)	0.047 (0.210)	0.03 (0.09)
Income3	−0.054 (0.138)	−0.105 (0.116)	0.087 (0.204)	−0.04 (0.09)
Income4	−0.067 (0.141)	−0.091 (0.118)	−0.015 (0.207)	−0.08 (0.09)
Income5	0.033 (0.144)	−0.059 (0.122)	−0.128 (0.211)	−0.07 (0.09)
Income6	0.151 (0.144)	0.048 (0.123)	−0.156 (0.210)	−0.07 (0.09)
Income7	0.097 (0.148)	−0.027 (0.126)	−0.254 (0.214)	−0.14 (0.10)
Income8	0.292** (0.147)	0.069 (0.127)	−0.159 (0.213)	−0.08 (0.10)
Income9	0.366** (0.147)	0.138 (0.129)	−0.198 (0.214)	−0.08 (0.10)
Income10	0.460*** (0.148)	0.157 (0.130)	−0.192 (0.216)	−0.09 (0.10)
Education2	0.069 (0.049)	0.018 (0.042)	0.033 (0.072)	−0.005 (0.03)
Education3	−0.012 (0.070)	−0.016 (0.062)	0.126 (0.098)	0.01 (0.05)
Education 4	−0.113 (0.083)	−0.110 (0.076)	0.293*** (0.112)	−0.03 (0.06)
Education(.)	−0.013 (0.147)	0.033 (0.125)	0.251 (0.207)	0.07 (0.10)
Self-employed	−0.119 (0.130)	0.033 (0.113)	−0.167 (0.182)	0.05 (0.09)
Retired	0.111 (0.069)	−0.012 (0.063)	−0.156* (0.094)	−0.08 (0.05)
Unemployed	−0.043 (0.156)	−0.113 (0.135)	−0.028 (0.215)	−0.14 (0.11)
Single	−0.159* (0.092)	0.039 (0.078)	−0.015 (0.133)	0.08 (0.06)
Widow	−0.073 (0.073)	−0.062 (0.063)	0.084 (0.103)	−0.02 (0.05)
Divorced	−0.028 (0.064)	−0.022 (0.056)	0.076 (0.088)	−0.02 (0.05)
Number of children	−0.028 (0.022)	−0.011 (0.019)	−0.008 (0.032)	0.004 (0.02)
Adult child	0.048 (0.076)	−0.037 (0.068)	−0.107 (0.103)	−0.06 (0.05)
Western immigrant	−0.040 (0.126)	−0.141 (0.114)	0.019 (0.165)	−0.13 (0.10)
Non-Western immigrant	0.062 (0.114)	0.333*** (0.103)	−0.139 (0.161)	0.14* (0.08)
Comorbidities	−0.021*** (0.004)	−0.012*** (0.004)	0.005 (0.006)	−0.005* (0.003)
Distance instrument	0.015*** (0.001)			
σ_0		1.144*** (0.021)		
ϱ_0		0.821*** (0.030)		
σ_1			0.995*** (0.051)	
ϱ_1			−0.555*** (0.095)	
Constant	−0.229 (0.569)	4.444*** (0.471)	4.478*** (0.711)	3.96*** (0.25)
Observations	5,043	3,882	1,161	5,043

Note: The estimates in columns (1-3) are based on an endogenous switching regression model for using the extended waiting time guarantee, i.e. being treated at a private hospital. The estimates in column (4) are from the extended model (reported in table 7), i.e. they are based on a OLS regression without the selection correction. The models include year fixed effects and controls for age using the age bands 18-35, 36-45, 56-65, 66-75, 76-85 and 85+. Standard errors in parentheses.
* p < 0.10, ** p < 0.05, *** p < 0.01.

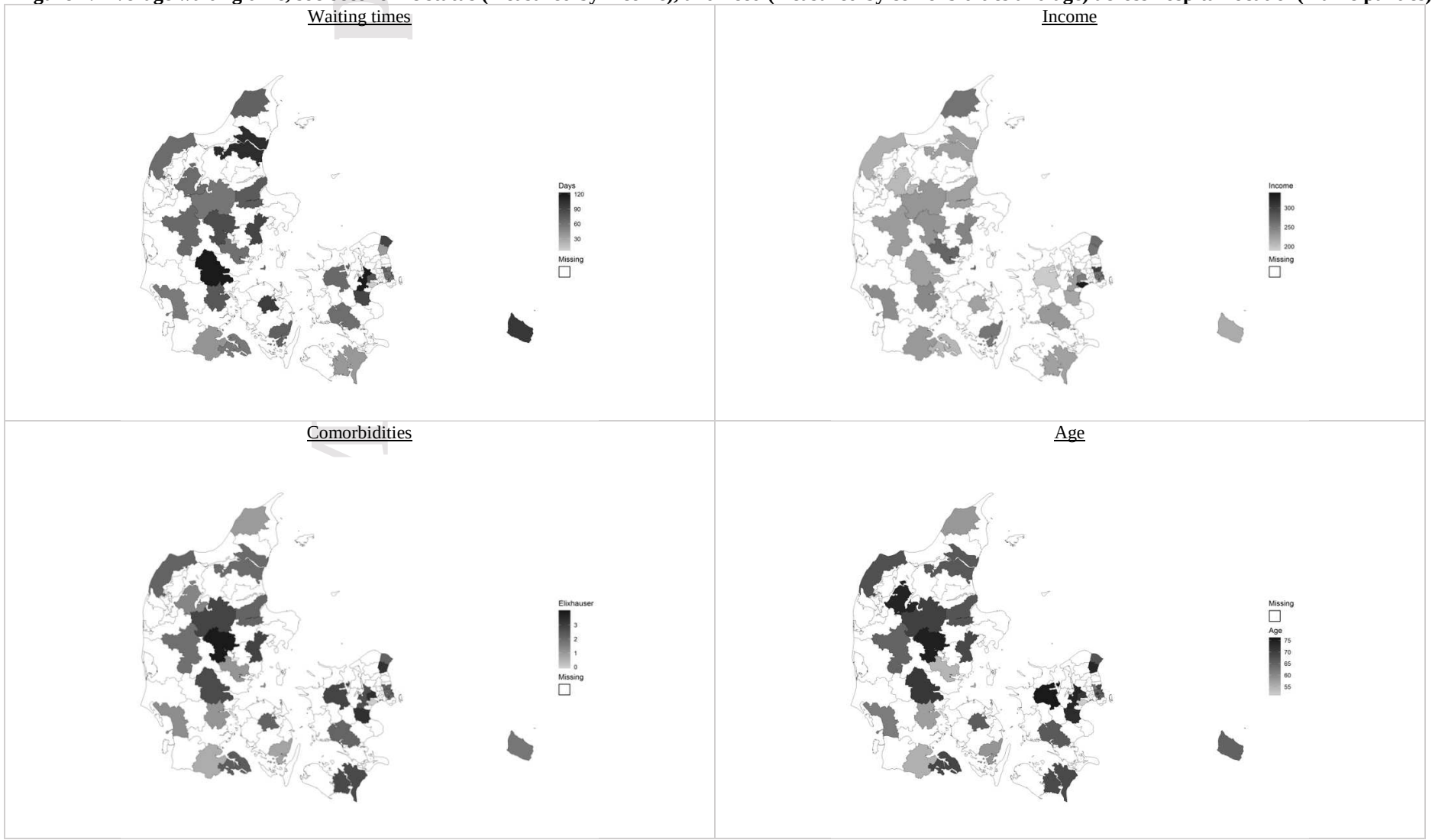
Table 6: Extended model controlling for selection due to use of the extended choice of provider under the waiting time guarantees (women)

	Cataract			
	Dependent variable:	*Dependent variable:*		
	Use of the guarantee	log total waiting time (days)		
		Public hospitals (selection correction)	Private hospitals (selection correction)	All hospitals (no selection correction)
	(1)	(2)	(3)	(4)
Income2	−0.006 (0.051)	−0.011 (0.030)	0.210*** (0.068)	0.04 (0.03)
Income3	0.045 (0.050)	0.004 (0.030)	0.240*** (0.067)	0.04 (0.03)
Income4	0.115** (0.051)	−0.037 (0.031)	0.260*** (0.068)	−0.01 (0.03)
Income5	0.054 (0.053)	−0.049 (0.032)	0.241*** (0.071)	−0.01 (0.03)
Income6	0.186*** (0.055)	−0.028 (0.034)	0.152** (0.072)	−0.05 (0.04)
Income7	0.191*** (0.057)	−0.060* (0.035)	0.207*** (0.074)	−0.06* (0.04)
Income8	0.235*** (0.058)	−0.063* (0.037)	0.137* (0.076)	−0.11*** (0.04)
Income9	0.231*** (0.059)	−0.084** (0.038)	0.130* (0.076)	−0.13*** (0.04)
Income10	0.289*** (0.060)	−0.095** (0.039)	0.067 (0.076)	−0.20*** (0.04)
Education2	0.172*** (0.018)	−0.021* (0.012)	−0.029 (0.023)	−0.09*** (0.01)
Education3	0.154*** (0.026)	−0.013 (0.017)	−0.043 (0.032)	−0.07*** (0.02)
Education 4	0.271*** (0.051)	0.065* (0.039)	−0.165*** (0.058)	−0.15*** (0.04)
Education(.)	0.041 (0.052)	−0.040 (0.032)	0.011 (0.069)	−0.05 (0.03)
Self-employed	0.109 (0.101)	−0.065 (0.073)	−0.230** (0.113)	−0.16** (0.08)
Retired	−0.146*** (0.036)	0.021 (0.024)	−0.003 (0.045)	0.05** (0.02)
Unemployed	0.034 (0.065)	−0.099** (0.041)	0.113 (0.082)	−0.06 (0.04)
Single	−0.003 (0.038)	0.014 (0.024)	−0.202*** (0.049)	−0.05** (0.03)
Widow	0.064*** (0.019)	0.020* (0.012)	−0.069*** (0.025)	−0.02* (0.01)
Divorced	0.137*** (0.023)	−0.004 (0.015)	−0.069** (0.029)	−0.09*** (0.02)
Number of children	−0.057*** (0.009)	−0.008 (0.005)	−0.004 (0.012)	0.01** (0.01)
Adult child	0.129*** (0.030)	−0.018 (0.019)	0.007 (0.038)	−0.05*** (0.02)
Western immigrant	0.008 (0.046)	−0.043 (0.030)	0.033 (0.056)	−0.03 (0.03)
Non-Western immigrant	0.079 (0.049)	0.084*** (0.032)	0.095 (0.062)	0.03 (0.03)
Comorbidities	−0.005*** (0.002)	−0.001 (0.001)	−0.001 (0.002)	−0.0003 (0.001)
Distance instrument	0.022*** (0.0004)			
σ_0		0.836*** (0.003)		
ϱ_0		0.070*** (0.024)		
σ_1			0.931*** (0.007)	
ϱ_1			0.065 (0.041)	
Constant	−1.587*** (0.241)	4.345*** (0.101)	3.879*** (0.433)	4.37*** (0.10)
Observations	39,674	30,510	9,164	39,674

Note: The estimates in columns (1-3) are based on an endogenous switching regression model for using the extended choice of provider under the waiting time guarantees, i.e. being treated at a private hospital. The estimates in column (4) are from the extended model (reported in table 8), i.e. they are based on a OLS regression without the selection correction. The models include year fixed effects and controls for age using the age bands 18-35, 36-45, 56-65, 66-75, 76-85 and 85+. Standard errors in parentheses.

* p < 0.10, ** p < 0.05, *** p < 0.01.

Figure 4: Average waiting time, socioeconomic status (measured by income), and need (measured by comorbidities and age) across hospital location(municipalities)



Note: The figure shows patients' average total waiting times (days), household equivalent disposable income (DKK 1,000), Elixhauser-van Walraven Comorbidity Index, and age (years). We include patients undergoing the hospital procedures hernia, cataract, gallstone, knee replacement, hip replacement, hysterectomy, and prostatectomy. The patients are linked to the municipality of their provider. The municipalities with missing observations do not have any providers included in our analyses.

6. DISCUSSION

Inequalities in access to health care is a concern for policymakers across health systems. Waiting times is an important dimension of patient responsiveness, and inequalities in this domain have been documented in some countries. Denmark is an interesting case study because it is characterised by a low level of income inequality (OECD, 2019a), but health inequalities have been increasing in recent years (Brønnum-Hansen & Baadsgaard, 2008; Christiansen et al., 2018). Using rich individual-level administrative data, we investigate the role of different factors that can explain waiting time inequalities in socioeconomic status.

As we are unable to control for unobserved factors (e.g. patients' and their family members' health literacy) that may be associated with both waiting time and socioeconomic status, we are cautious not to interpret our findings as causal. However, we have minimised the concern for unobserved confounders by including a rich set of control variables, including proxies for severity such as age and the Elixhauser-van Walraven Comorbidity Index commonly used in the literature. These variables have limitations. For example, the comorbidity index does not account for the differential effect of comorbidities on patients' needs depending on the procedure. Among the severity measures, age is the only strong determinant of waiting time. Given waiting time guarantees were differentiated based on the severity of patients' illnesses, this finding is perhaps surprising. On the other hand, most of the procedures considered are elective ones. Severity may be better proxied with condition-specific measures (e.g. that relate to patient mobility and pain for hip replacement, or visual acuity for cataract surgery) that are rarely available for large samples. When available, the degree of waiting time prioritisation based on severity still remains limited (see Gutacker, Siciliani and Cookson (2016) for hip replacement).

Our key findings are as follows. Only for a few procedures we find a socioeconomic gradient in waiting times related to income and education. When we control only for patient severity, we find that patients wait less for cataract surgery if they have a higher income (9-18%, 8-17 days) or educational attainment (3-16%, 3-15 days). We also find that men with a higher income wait less (6-7%, 4-5 days) for a hernia surgery. The income gradient for hernia can be explained by differences in labour market and marital status, and country of origin. Labour market and marital status play a minor role, i.e. men wait longer for a hernia surgery if they are retired (3%, 2 days), single (4%, 3 days), divorced (3%, 2 days), whereas non-Western immigrants (20%, 13 days) wait substantially longer. The latter result also extends to other procedures, i.e. gallstone surgery, knee replacement, and prostatectomy. For around half of the procedures, we find that non-Western immigrants wait 11-26% (8-18 days) longer than native Danes, and the effect is both economically and statistically significant.

In Denmark, patients who receive a referral to a hospital are covered by a waiting time guarantee. Patients who exercise the right to private treatment under the waiting time guarantee may wait significantly less than patients who do not make use of the guarantee. Use of the guarantee requires action on the side of the patient. We find that patients' use of this guarantee is limited for most of the selected procedures, with the exception of cataract surgery and prostatectomy. For these two procedures, we find that there is a gradient in using the guarantee in favour of patients with the highest education and income level. Thus, although the guarantee may be reducing waiting times for some patients, this may come at the cost of larger socioeconomic inequalities in access to care. However, we find that the inequalities in waiting time related to income and education for cataract surgery persist after controlling for this self-selection to private providers.

When we control for hospital factors (through hospital fixed effects), our within-hospital estimates suggest that the inequalities with respect to income and education disappear. This finding suggests that inequalities are largely due to differences in waiting times *across* hospitals where patients seek care, rather than patients being treated differently *within* the hospital. Inequalities across hospitals may arise due to patients with higher socioeconomic status living in areas where hospitals have a higher bed capacity, are better staffed, or can attract more skilled workers than hospitals located in more deprived areas. In that case, additional

resource allocation to hospitals located in more deprived areas may be an effective policy to reduce waiting time inequalities.

The socioeconomic gradient we estimate is smaller than what is reported for Denmark in a study by Siciliani and Verzulli (2009) using survey data in 2004. Siciliani and Verzulli (2009) find that higher educated patients wait 66% (2.4 months) less than those with low education for (any type of) non-emergency surgery, while there is no impact on access to specialist consultations. Our estimates are similar in size to what is found in other register-based studies for hip replacement in England (Laudicella et al., 2012) and Norway (Monstad et al., 2014) and for all elective inpatient and outpatient stays in Norway (Kaarboe & Carlsen, 2014), but lower than what Tinghög et al. (2014) find for Sweden, where waiting time is around 30% higher for patients in the lowest income group compared to the highest earners for orthopaedics and general surgery. However, as these results use different definitions of waiting times, include different controls, and have different baseline waiting times the results are not directly comparable.

Our study is the first to distinguish between active and passive waiting time, i.e. waiting time due to provider or patient delay. Introducing a more nuanced measure of waiting time enables us to assess the degree to which inequalities are driven by certain types of patient behaviour, for example patients postponing or cancelling appointments, which increase passive waiting time. However, our findings are robust to using active waiting time as our dependent variable, rather than total (active plus passive) waiting time, indicating that the identified inequalities are not due to patients with lower socioeconomic status having a longer passive waiting time.

Our finding of longer waiting times for non-Western immigrants persists within hospitals. Around 3-4% of the total patient population may be affected by these inequalities (see appendix A23). Our result for immigrants is aligned with a Swedish study by Smirthwaite et al. (2016) who find that patients born outside of the Nordic countries experience longer waiting times for cataract surgery. In contrast, a Swedish study by Tinghög et al. (2014) finds a gradient for income, but no statistically significant effect of country of origin, except shorter waiting times for gynaecology for labour market active immigrants. However, Tinghög et al. (2014) do not distinguish between Western and non-Western immigrants.

We are unable to ascertain if the identified inequalities for non-Western immigrants is due to indirect or direct discrimination. Non-Western immigrants may be less familiar with or less able to "navigate the system" (indirect discrimination). The inequality may also arise from the encounter between the patient and the health professionals, for example due to prejudices of doctors, clinical uncertainty due to difficulties of doctors in interpreting symptoms from minorities (which may be seen less often), or stereotypes held by health professionals about minorities' health-related behaviour (Balsa & McGuire, 2003). It may be that the explanation is systemic, for example if non-Western immigrants need assistance from an interpreter. However, on average these first-generation non-Western immigrants have been residing in Denmark for 19 to 29 years, depending on the procedure (see appendix A24), indicating that they may be familiar with the language. The finding for non-Western immigrants suggests that a policy to address inequality for immigrants should focus more on factors within rather than between hospitals. For example, policies may focus on developing a waiting list management system that simplifies procedures, eliminates communicational barriers between patients and hospital personnel, or supports patients who are not native speakers, for example by improving access to interpreters. The impact of such policies on inequality in waiting times is an important avenue for future research.

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