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Socioeconomic Gradients in Waiting Time for Hospital Admissions

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Socioeconomic Gradients in Waiting Time for Hospital Admissions[*]

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Abstract:

Waiting time is a rationing mechanism that is used in publicly funded healthcare systems as a mean to ensure equal access for equal need. However, several studies suggest that individuals with higher socioeconomic status wait less. We provide results on the gradient when socioeconomic status is measured at the individual level and the waiting times include all elective somatic hospital treatments. We also shed light on the magnitude of the aggregation bias by analyzing socioeconomic gradients in waiting times when education and income are on three different aggregation levels, and we provide insight into where and how the socioeconomic gradient originates. Our socioeconomic gradient is modest compared with the literature. The main effects are through an increased probability of being admitted directly to an inpatient stay. When socioeconomic status is measured on an aggregate level, we find much larger effects of the socioeconomic variables, but the same holds true for the standard errors. Our results now mimic the socioeconomic inequalities common from the literature. A researcher who only has access to the aggregate data could easily interpret the magnitude of the gradients and the significant levels as within the expected range and conclude that the estimated (aggregate) gradients are reasonable.

Keywords: Access to care, aggregation bias, socioeconomic gradient, waiting time

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1. Introduction

Waiting times are a main policy issue in publicly funded health care systems. In these systems, co-payments are typically low, and waiting times function as the implicit rationing mechanism to hospital care . However, waiting time leads to dissatisfaction and may cause deterioration in a patient's health status. In addition, waiting times may lead to prolonged sickness absence and lost productivity at work. Long waiting times have been on the political agenda in many countries, and politicians have put down considerable effort to reduce waiting times, (Siciliani et al., 2013).

A recent health economics literature, surveyed in (Landi et al., 2018; Siciliani, 2016), has shown that there is a socioeconomic gradient in waiting times. These studies find that high socioeconomic status, measured by education or income level, is associated with lower waiting time for hospital admissions. Most studies are based on administrative hospital data and focus on waiting times for specific procedures/treatment and measure patients' socioeconomic status as an aggregate measure from patients' residential area. Typical results are that the socioeconomic gradient in waiting time is large as patients with high socioeconomic status wait up to 8-15% shorter than patients with low socioeconomic status, that inequalities in waiting times arise both across and within hospitals, and that inequalities in waiting time are smaller and sometimes disappear when hospitals fixed effects are added to the analyses. The main conclusion is that one can question if rationing by waiting times fulfills the goal of access to care based on need. The studies are typically silent on the mechanism behind the gradient.[1]

Studies based on administrative hospital data and specific procedure/treatment like hip replacement, knee replacement, cataract repair and revascularization procedures include (Cooper et al., 2009; Johar et al., 2013; Laudicella et al., 2012; Monstad et al., 2014; Moscelli et al., 2018; Petrelli et al., 2012; Sharma et al., 2013; Simonsen et al., 2020; Smirthwaite et al., 2016; Tinghög et al., 2014). One benefit of this approach is that it ensures precise measures of waiting times and the ability to control for patient severity of illness compared to studies based on survey data (Siciliani and Verzulli, 2009). On the other hand, whether rationing by waiting times fulfills the (often stated) goal of equal access to care for patients in equal need is best analyzed by looking at the socioeconomic gradients for a broad set of hospital services.

Administrative hospital data do seldom contain information of income and education and patients' socioeconomic status is typically measured as an aggregate socioeconomic measure from population cells that combine gender, age, and patients' residential area (municipality). While this approach has provided insight into the question of whether rationing by waiting time fulfills the goal of access to care based on need, the results are vulnerable for aggregation biases.[2] That is, a person's measured socioeconomic status will be biased if a patient's socioeconomic status diverges from the average socioeconomic status in the population cell. This raises the question of whether the socioeconomic gradient found in the literature provides the correct answer to the question of how individual socioeconomic status affects waiting times.

[1] Two exceptions are (Moscelli et al., 2018; Simonsen et al., 2020). The authors of the first paper analyze whether people of difference socioeconomic status have different preferences to exert choice of hospital and find that choice can explain 12 % of the wait gradient. The authors of the second paper explore the Danish waiting time guarantee and find that there is a socioeconomic gradient in the use of the guarantee for cataract surgery and prostatectomy.

[2] Whenever hypotheses about individual level relationships are tested with data which sums or averages individual level data the aggregation problem may arise (Deaton and Muellbauer, 1980).

Some studies have access to individual level data on socioeconomic status, see e.g. (Monstad et al., 2014; Petrelli et al., 2012; Simonsen et al., 2020; Smirthwaite et al., 2016; Tinghög et al., 2014), and some studies use data for all elective somatic hospital stays (Carlsen and Kaarboe, 2015; Johar et al., 2013; Kaarboe and Carlsen, 2014). However, we are not aware of any study with hospital data on all elective hospital stays *and* individual level data on socioeconomic status. This brings us to the aim of this study as we make three contributions to the literature.

First, we contribute by providing results on the gradient when socioeconomic status is measure *at the individual level* and the waiting times include *all elective somatic hospital treatments*. Second, we shed light on the magnitude of the aggregation bias by analyzing the socioeconomic gradient in waiting times when education and income are registered at three different aggregation levels: The individual level, the primary care physician level, and the municipal level. Thirdly, we provide insight into where and how the socioeconomic gradient originates. We can do this since our data allows us *to decompose the gradient on different pathways* into the hospital. E.g. whether patients are referred directly to an inpatient or day care[3] admission or whether patients are referred to an outpatient hospital consultation before (possible) being admitted to a hospital stay.

Observing socioeconomic gradients in waiting times do not automatically imply that goals of access to care based on need are not met. One reason is that patients with different socioeconomic status have different disease patterns, and some diseases entail longer waiting times than others do. Another explanation for observed socioeconomic gradients might be that people with high and low socioeconomic status receive treatments at different hospitals, and that waiting times differ among hospitals. Most studies will thus check how much of the gradient is left after controlling for severity and for hospital-specific conditions. A third explanation is that education and income affect how people can navigate health care systems and overcome bureaucratic hurdles. This mechanism might be *particularly important* if there are different pathways people can use *to* access hospital care and waiting times for hospital care differ among these pathways.

A health system where access to (elective) hospital care requires a referral (typically by a general practitioner, GP) gives rise to multiple pathways into hospital care. One pathway is that the patient visits a GP to get a referral to a hospital when s/he needs (planned) treatment. Based on the referral letter sent from the GP, the hospital admits the patient *directly* to inpatient/day care treatment. The patient's (hospital) waiting time will be the time from the hospital receives the referral letter to the start of the (inpatient/day care) treatment. A second type of pathway occurs if the hospital (specialist) responds to the referral letter by admitting the patient to the hospital's outpatient clinic. Based on the findings from the outpatient clinic the patient might be admitted to inpatient or day care treatment. In this *indirect* case, the patient's waiting time consists of two parts; from the hospital receives the referral letter to the first outpatient consultation, and from the outpatient consultation to the start of the (inpatient/day care) treatment.[4]

Different pathways give rise to several questions. First, are there any differences in waiting times between the direct and the indirect pathways? Second, are patients of different socioeconomic status more likely to be admitted through the fastest pathway? Third, are there any socioeconomic gradients in the waiting time within the pathways? Finally, if there is a socioeconomic gradient on the indirect pathway, where does it occur? From the GP to the outpatient consultation, or from the outpatient consultation to the start of inpatient hospital treatment?

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[3] Day care admissions are typically day surgeries with a hospital stay of at least five hours.

[4] A third type of pathway occurs if the patient decides to go private, i.e. to visit a private specialist to get a hospital referral letter.

We use Norwegian administrative data to shed light on which of these channels contribute to a socioeconomic gradient in waiting times. We have access to a rich data set of hospital patient episodes that allows for controls for patients' medical condition (severity of illness) and for hospital fixed effects. The hospital data are merged with individual data on education and income, data on the patient's general practitioner, and on patients' travel time to the hospital. Hence, our data set consists of individual measures of socioeconomic status and individual data of GP and hospital visits.

We estimate a series of regressions explaining waiting time in Norwegian somatic hospitals as a function of education level and income along the alternative pathways. We estimate two specifications. In the first specification, we do not control for variables that describe differences across patients in factors shaping the supply of health care services faced by the patient. That is, we are estimating *gross gradients*, i.e. differences in waiting time for patients with different socioeconomic status. In the second specification, controls that describe the health sector are included. Examples of such controls are travel time to the hospital where patients are treated, the hospital patients are treated at, and the patients' GP. These regressions provide insight into whether patients of different socioeconomic statues are treated differently by the health care sector.

Our analyses show that all channels contribute to the socioeconomic gradient in waiting time. The total effects are relatively modest compared with the literature, about 3-4% reduction in waiting time for both men and women with highest socioeconomic status relative to those with the lowest. The main effects are through an increased probability of being admitted on the direct pathway, with a magnitude of about three percentage point higher for those with the highest level of socioeconomic status relative to those with the lowest. The results are similar for male and woman, and the results are dampened (by about 0,5 percentage point) when controls that describe the health sector are included. Within the specific pathways the effects are smaller and not always significant. For example, the waiting time differences on the indirect pathway are only significant for patients with intermediate socioeconomic status (e.g. only secondary education) relative to those with low socioeconomic status, and only when health sector controls are not included.

Turning to the effects of different aggregation levels (GP level and municipal level) for the socioeconomic gradients we measure the sex specific socioeconomic status as the shares of the inhabitants with the respective education or income levels either for the GP where the patient is listed or in the patient's home municipality.[5] Comparing the results to the analyses with individual level socioeconomic data we find much larger effects of the socioeconomic variables, but the same holds true for the standard errors. More specifically, comparing the coefficients of the patients with the highest socioeconomic status with those with the lowest, we find that the coefficients are about 2 (5) times higher for men (women) when the socioeconomic variables are aggregated to either the GP or the municipal level. The standard errors are also higher than in the analyses based on individual level socioeconomic data and differ for the two aggregation levels: The cruder the aggregation is the larger the standard errors. We find few significant effects when socioeconomic data are aggregated to the municipal level and hospital sector controls are included. In conclusion, these results mimic the socioeconomic inequalities common from the literature. A researcher who only has access to the aggregate data could easily interpret the magnitude of the gradients and the significance levels as within the expected range and conclude that the estimated (aggregate) gradients are reasonable.

[5] These two aggregation levels differ in size as the average municipality is about 10 times larger than the average GP list size.

1. Institutional setting

Norway has a National Health Service system financed through general taxation. The Norwegian health care sector is organized into primary and secondary health care sectors. The former is the responsibility of municipalities while the latter is the responsibility of the central government.

Our analyses cover the years 2010-2013. There were 429 municipalities in Norway in 2012 with an average population of 11 655 inhabitants. In 2012-13 there were about 4 300 GPs in the National Health Services (Gaardsrud, 2021). The GPs provide the patients' initial medical services in a nonemergency case.

A regular General Practitioner Scheme is implemented (since 2001). The share of the inhabitants that are listed with a GP are close to 99%. In 2015 the average list size was about 1 130 individuals. GPs with an open list will automatically be assigned new patients who apply for being listed with them. Each inhabitant can switch GP twice per calendar year, and about 3 % of the patients do so annually (Aas et al., 2021).

The secondary health sector is organized through four regional health authorities (RHA).[6] The authorities have the responsibility for commissioning and financing health care services for the population in their region and providing these services. The provision takes place mainly through the RHA's own enterprises (hospitals), private not-for-profit hospitals which contract with an RHA and private specialists with a practice allowance from the RHA. In addition, specialist services are sometimes supplied by private specialists who operate outside the National Health System, i.e. a specialist without a practice allowance from the RHA.

There is a referral system for planned treatment, as patients must visit a GP to get a referral to a hospital when they need (planned) treatment.[7] In most cases patients will visit the GP where they are listed, but patients can also choose to visit a private practitioner to get a referral. In these cases, the patient would have to pay the full cost of the consultation at the benefits of shorter waiting time to see the private practitioner.

A hospital specialist will evaluate the referral letters and decides if patients need elective hospital treatments or not. In the latter case, patients are back-referred to their GP. If the patient needs hospital treatment, the hospital specialist will decide whether the patient is to be admitted directly to inpatient treatment, or if the patient is referred to an outpatient consultation at the hospital. In the latter case, and after the outpatient consultation, the patient is either admitted to inpatient treatment or referred back to the GP. Figure 1 shows the different pathways outlined above.

[6] (Ringard et al., 2013) provides a detailed description of the Norwegian hospital system.
[7] In the case patients need emergency treatment, they will be treated directly at the hospital.

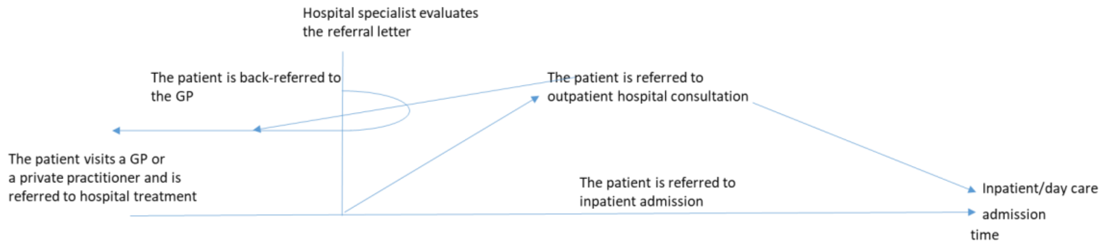

Figure 1. Pathways to treatment

2. Data

The empirical analyses make use of data merged from four data sets. Our data source of nonemergency hospital treatment is the National Patient Register (NPR) for the period 2010-2013. The NPR has information about all hospitals, referral and admission dates, primary diagnosis, patient's birth year and gender and patient's place of residence (municipality or part of city) for all patient episodes (both inpatient and outpatient treatment) in somatic hospitals. For patients on the direct pathway, we set waiting time equal to the number of days between the hospital receives the letter of referral and the patient is admitted to treatment. For patients on the indirect pathway, waiting time consists of two parts: i) waiting times in days from referral to outpatient visit, and ii) and waiting times in days from outpatient visit to admission.[8]

The second data set measures socioeconomic status. It contains individual data on education and income. The data is from Statistics Norway. Our income variable is annual pre-tax income from work, property income, taxable transfers and tax-free transfers received during the calendar year. The education variable specifies an individual's highest level of education (primary; secondary or tertiary education). Income and education level are registered for the year of the hospital treatment.

The third data set contains data on the GPs and their patients. Specifically, it contains information of the inhabitants who are listed with a specific GP. This data set is from the Norwegian Health Economics Administration (HELFO).

The fourth data set measures the distance from a municipality to the municipalities with a hospital. Distance is measured in travel time by car from one municipality centre to another. We have constructed two dummy variables to measure patients' travel time from their municipality of residence to (acute) hospitals. The first (second) dummy variable captures travel time between 30-60 minutes (more than 60 minutes). We include these variables when we analyse the socioeconomic gradients and control for supply of health care services.

3.1 Sample selection

Since we focus on waiting time to admission, we only include elective treatments that contain at least one inpatient or day care stay. As a result, we drop visits at private specialists, and outpatient visits

[8] We do not have information on whom sent the referral letter to the hospital. In most cases it is the patient's GP, but it might also be a private specialist with or without a practice allowance. If the private specialist has a practice allowance the patient needs a referral from the GP so that the total waiting time consists of three parts: i) from the patient contacts the GP to the GP visit, ii) from the GP visit to the specialist visit, and iii) from the specialist visit to the hospital admission. If the specialist does not have a practice allowance, the patient can see the specialist directly, with a very short waiting time, but pays the full cost of the visit. In this case, the waiting time consists of the wait between the specialist visit and the admission to the hospital.

where patients are not admitted to an inpatient/day care stay. We also drop patients with more than 18 months of waiting time (due to potential measurement errors). Furthermore, we drop patient stays related to pregnancy and childbirth. To focus on patients that are in the age where labor force participation is relatively high, we drop patients below the age of 25 (many are still under education) and above the age of 64 (the average retirement age in Norway). Finally, for some patients we miss information on their educational level, and for some admissions we miss information about the patient's GP. There are 6 616 patient stays with missing observations on the patient's educational level and 4 637 admissions with missing information on the patient's GP. Hence, the number of observations is slightly lower than otherwise in the analyses that control for the patient's GP. There is no missing information on which hospital that treated the patient.

Our sample consists of elective treatments from 1st July 1 2011 to 31st December 2013 on clinical pathways that contain at least one inpatient/day care stay for patients aged 25-64.[9] The data set contains 395 228 patient pathways for 330 604 unique patients of which 172 384 (52.1%) are men and 222 844 (47.9%) are women.[10] 189 094 (43.5%) patient pathways are direct, and 245 094 (56.5%) pathways consist of an outpatient consultation before inpatient admission.

Independent of pathway, most common (elective) treatments are various day surgeries. Day surgery on knee and leg is the treatment with the highest number of admissions (22 345).[11] Other high volume day surgeries are surgery on uterus (benign) (15 953) surgery on humerus/elbow/forearm (11 635), curetting/cone biopsy (day surgery, 10 710) and sleep apnoea (8 415). Complex rehabilitation is one high volume treatment that are only seen on the direct pathway, and smaller surgery on the urinary bladder and surgery on spinal column (excluding spondylose) are two treatments that are only seen on the indirect pathway. Surgeries on uterus, day surgery related to curetting/cone biopsy and day surgeries on knee or leg (8 889) are the most common treatments for women, while day surgeries on knee or leg (13 465), surgery on humerus/elbow/forearm (6 230) and sleep apnoea (5 963) are the three most common treatments for males.

3. Methodology and empirical analysis

Table 1 presents summary statistics. The average age of men waiting for admission is about 49 years. Women are on average about two years younger. Men experience shorter waiting time than women; average waiting time for women is about 5.4 days longer than for men. There are significant differences in waiting times between the direct and the indirect clinical pathway; the average waiting time along the indirect pathway is more than double the direct one. This holds true for both men and women. However, a larger share of men got direct access to admission; about 48 % of the men and about 41 % of the women got direct access. For patients on the indirect pathway to admission, women wait about three days shorter than what men do. About 44 % of the waiting time is to the first consultation irrespectively of the patient's sex.

Turning to the socioeconomic data, we see that there are large income differences between men and women both with respect to average and median income. Average income is NOK 529,000 (€53,000) for men and about NOK 382,000 (€38,000) for women. I.e. average income of men is about 38 % higher

[9] Since we have data from 1st January 2010 and we include waiting time up to 18 months, we exclude all admissions before 1st July 2021 to include all outpatient and inpatient treatments for a patient pathway.
[10] The large number of fixed effects sometimes implies unique combinations of certain fixed effects. Hence, the sum of the observations used in the analyses are slightly smaller than the total number of observations.
[11] Number of admissions in parentheses.

than for women. To characterize the education level of the population, we compute the share of patients that had completed secondary education (but without tertiary education) and the share of patients that had completed at least one year of tertiary education. The share of patients with tertiary education is higher among women; 0.35 versus 0.25 for men, whereas the share of secondary education is highest for men; 0.51 versus 0.41 for women.

[Table 1 about here]

From the NPR data set, we have information about patients' medical condition. To identify the relationship between waiting time and socioeconomic status, and to analyze variations in waiting time for patients with the same medical condition, we include fixed effects for the patients' Diagnosis Related Group (DRG) and medical specialty. There are 686 (50) different DRGs (medical specialties) for male patients in the sample. The corresponding numbers for the female patients are 707 DRGs and 48 medical specialties.

4.1 *The socioeconomic gradient in waiting time*

To analyze how income affects waiting time we have constructed hospital specific income quartiles. That is, we measure a patient's income relative to other patients' (aged 25-64) income treated at the same hospital. [12]

In addition to controlling for the patients' diagnosis, medical specialty, and socioeconomic status, we include controls related to characteristics of the supply of health services patients receive. We include fixed effects for hospitals, two variables describing patients' travel time to the hospital, and fixed effects for the patients' GP.

Let $E(WT_i)$ denote the expected waiting time for patients in the socioeconomic group $i = low, middle, high$. Let P_i denote the probability of direct access for group i, WT_i^{DIR} denotes waiting time given direct access of group i, and let WT_i^{INDIR} denote the waiting time of indirect access for group i. The indirect waiting time consists of two parts. The first part is the waiting time to outpatient consultation that we denote WT_i^{CONS}. The second part we denote WT_i^{AMD}, it measures the waiting time from consultation to admission. Both are measured in days. Hence, $WT_i^{INDIR} = WT_i^{CONS} + WT_i^{ADM}$.

[12] As a sensitivity test, we also constructed income quartiles based on a patient's income relative to the Norwegian population (aged 25-64). We obtain similar results by both measures.

Table 1. Summary statistics

	Mean	SD	Median	Max	Min
Male patients (172 384 admissions)					
Waiting time to admission (days)	125.6	119.5	88	547	0
Direct access to admission (dummy = 1 if direct access)	0.480			1	0
Direct access:					
Waiting time to admission (days)	77.5	91.4	45	547	0
Indirect access:					
Waiting time to admission (days)	170.1	125.0	140	547	0
Waiting time to consultation (days)	75.5	73.9	53	545	0
Waiting time from consultation to admission (days)	94.6	97.1	62	541	0
Age	48.7	10.9	50	25	64
Income (10^5 NOK)	5.29	4.87	4.53	610	-86
Secondary education (dummy = 1 is patient's highest education is secondary)	0.506			1	0
Tertiary education (dummy = 1 if patient has tertiary education)	0.251			1	0
Female patients (222 844 admissions)					
Waiting time to admission (days)	131.0	121.5	94	547	0
Direct access to admission (dummy = 1 if direct access)	0.412			1	0
Direct access:					
Waiting time to admission (days)	79.4	91.3	48	547	0
Indirect access:					
Waiting time to admission (days)	167.3	126.8	139	547	0
Waiting time to consultation (days)	73.3	74.3	50	542	0
Waiting time from consultation to admission (days)	94.0	97.0	62	545	0
Age	46.9	10.9	48	25	64
Income (10^5 NOK)	3.82	2.30	3.62	207	-47
Secondary education (dummy = 1 is patient's highest education is secondary)	0.417			1	0
Tertiary education (dummy = 1 if patient has tertiary education)	0.345			1	0

The expected waiting time differential between two socioeconomic groups, *i* and *j*, is given by

$$E(WT_i) - E(WT_j) = P_i WT_i^{DIR} - P_j WT_j^{DIR} + (1 - P_i) WT_i^{INDIR} - (1 - P_j) WT_j^{INDIR}$$
$$= (P_j - P_i)(WT_i^{INDIR} - WT_i^{DIR}) + P_j(WT_i^{DIR} - WT_j^{DIR}) + (1 - P_j)(WT_i^{INDIR} - WT_j^{INDIR})$$

The expected waiting time difference between two socioeconomic groups are caused by the following three effects; i) the difference in probability of being granted direct access, $P_j - P_i$, ii) the difference in waiting time given direct access, $WT_i^{DIR} - WT_j^{DIR}$, and the waiting time differential on the indirect path, $WT_i^{INDIR} - WT_j^{INDIR}$.

Figure 2 depicts the waiting time distribution.

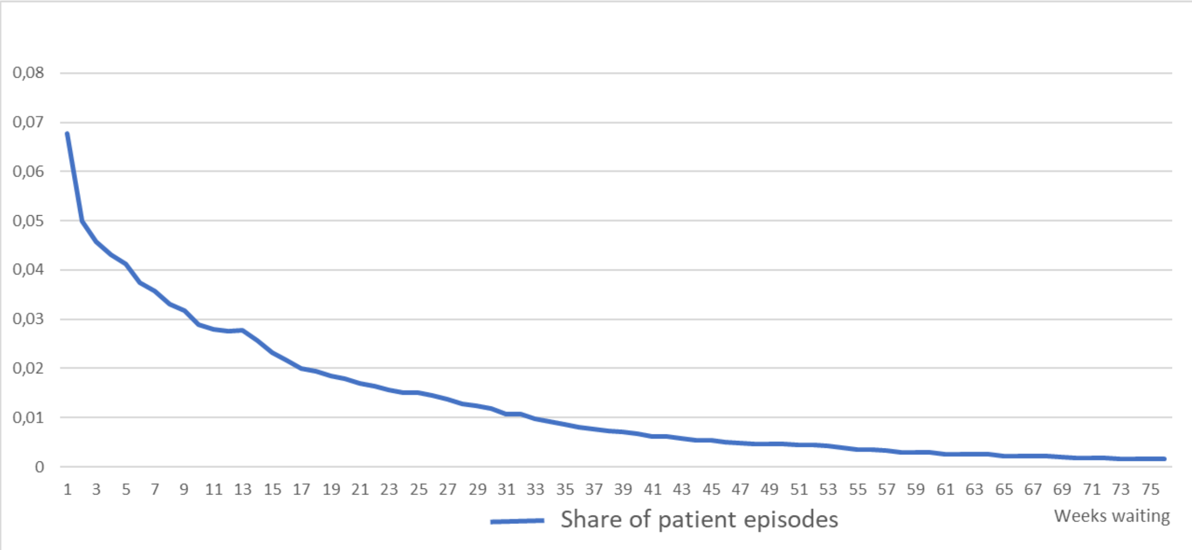

Figure 2: The distribution of waiting times

From the figure we see that the density of waiting time is decreasing with a long right tail. We have however chosen to analyze how socioeconomic status affects waiting time without log-transforming the waiting time distribution. Our rational is that we aim to disaggregate the difference in waiting times among the socioeconomic groups in the three ways a group can wait shorter; see above. By estimation the waiting times in days, the components of the waiting time differences are given directly by the regressions outlined below.

To analyze how socioeconomic status affects waiting times, we estimate the following ordinary least square (OLS) model.[13]

$$y_i = \delta_0 + \vec{\delta}_1 YEAR + \vec{\delta}_2 AGE + \vec{\delta}_3 DRG + \vec{\delta}_4 MS + \vec{\delta}_5 HOSP + \vec{\delta}_6 DIST + \vec{\delta}_7 GP + \vec{\delta}_8 SES + \varepsilon_i,$$

where y_i is either the number of days between the days of referral and admission/ outpatient consultation, the number of days between the outpatient consultation and admission, or the

[13] We estimate the probability of getting direct access with a linear probability model.

probability of direct access. AGE is a birth year-vector, YEAR is a year-vector, DRG is a vector of Diagnosis Related Groups, MC is a vector of medical specialties, HOSP is a hospital vector, DIST is a vector describing traveling time to the closest hospital, GP is a vector of GPs, SES is the patient's socioeconomic status (income or education level) and ε_i is an error term. The scalar δ_0 and the vectors $\vec{\delta}_1 - \vec{\delta}_8$ are parameters to be estimated.

We estimate two types of regressions. First, we do not control for variables that describe the health sector. That is, we are estimating the *gross gradients*, i.e. differences in waiting time for patients with different socioeconomic status. In the second type of regression we include controls that describe the health sector.

In the main text we have chosen to present the results in the case when socioeconomic status is measured by education and refer to the appendix for the regressions where income is used to measure the socioeconomic status. The rational is that the structure of the results is similar both when socioeconomic status is measured by income or education, and that education is a more stable measure of socioeconomic status than income (which may fluctuate over the years).[14]

Table 2 presents the results of the socioeconomic gradient in total waiting time. when all hospital stays (independent of pathway) are included. In regression 1 and 3, we present the results *without controls for supply of health care services* while regression 2 and 4 include these controls. All regressions include fixed effects for year, age, medical discipline, and DRG.

Education has a significant negative effect on waiting time for both male and female. In absolute value the effects are stronger for women; the relative effects are similar (women has slightly longer average waiting time). The magnitude is a 3-4% reduction in waiting times for those with (at least one year) of tertiary education compared to those with only primary education. From the table we also see that the supply side factors explain about 10-40 % of the waiting time gradient.

Table 2. Effect of education on total waiting time (in days)

	1	2	3	4
	Male		Female	
Primary education	Reference category			
Secondary education	-2.852 (-4.26)	-1.731 (-2.58)	-3.251 (-5.28)	-2.613 (-4.29)
Tertiary education	-4.162 (-5.33)	-3.684 (-4.60)	-5.134 (-7.99)	-4.345 (-6.65)
Health sector fixed effects*	No	Yes	No	Yes
R^2	0.177	0.243	0.202	0.255
N	169 022	166 618	219 517	217 498

t-statistics clustered at patient level reported in parentheses
All regressions include fixed effects for year, age, medical discipline, and DRG
*Hospital, Distance, GP

We next consider the socioeconomic gradients in the probability of direct access. Table 3 presents the results. We see a significant socioeconomic gradient of being admitted directly to admission. More

[14] We have also examined whether the relationship between waiting time and socioeconomic status varies according to age by estimating the gradients for the young (25-44 years) and the old (45-64 years). The results resemble what we find when all age groups are analyzed together. The results are available upon request.

specifically, the probability of being admitted 'on the fast track' is about one (three) percentage point higher for those with secondary (tertiary) education relative to those with only primary education. Including supply side factors reduced the gradient. The results are similar for male and female.

Table 3. Effect of education on the probability of being admitted on the direct way

	1	2	3	4
	Male		Female	
Primary education	Reference category			
Secondary education	0.009 (3.49)	0.006 (2.55)	0.014 (5.75)	0.010 (4.35)
Tertiary education	0.026 (8.22)	0.021 (6.80)	0.031 (11.77)	0.024 (9.45)
Health sector fixed effects*	No	Yes	No	Yes
R^2	0.211	0.344	0.198	0.312
N	169 022	166 618	219 517	217 498

t-statistics clustered at patient level reported in parentheses,
All regressions include fixed effects for year, age, medical discipline, and DRG
*Hospital, Distance, GP

The next table shows the educational gradient on the direct admission path. First, we notice that there are no significant effects of secondary education. There is a small effect on tertiary education; however, the effects are not significant on a five percent level when health sector fixed effects are included.

Table 4. Effect of education on waiting time to direct admission (in days)

	1	2	3	4
	Male		Female	
Primary education	Reference category			
Secondary education	-0.423 (-0.59)	-0.240 (-0.33)	-0.193 (-0.27)	-0.566 (-0.78)
Tertiary education	-2.035 (-2.44)	-1.417 (-1.62)	-1.849 (-2.47)	-1.460 (-1.89)
Health sector fixed effects*	No	Yes	No	Yes
R^2	0.228	0.316	0.209	0.290
N	81 095	79 650	90 546	89 376

t-statistics clustered at patient level reported in parentheses,
All regressions include fixed effects for year, age, medical discipline, and DRG
*Hospital, Distance, GP

Turing to the indirect pathway to admission, we first consider differences in waiting time to outpatient consultation. Table 5 presents the results. We notice that there are few significant effects for men. Only men with secondary education have significant shorter wait, and only with no supply side controls included. The effects of women are significant and women with the lowest educational level wait about 1,5 days longer than women with secondary and tertial education.

Table 5. Waiting time in days to consultation (indirect way)

	1	2	3	4
	Male		Female	
Primary education	Reference category			
Secondary education	-1.164 (-2.03)	-0.790 (-1.35)	-1.393 (-2.88)	-1.308 (-2.68)
Tertiary education	-0.437 (-0.65)	-0.746 (-1.06)	-1.615 (-3.19)	-1.672 (-3.21)
Health sector fixed effects*	No	Yes	No	Yes
R^2	0.179	0.254	0.218	0.273
N	87 866	86 673	128 920	127 870

t-statistics clustered at patient level reported in parentheses,
All regressions include fixed effects for year, age, and medical discipline, and DRG
*Hospital, Distance, GP

Second, we consider differences in waiting times from outpatient consultation to admission. Table 6 presents the results. First, we notice that most of the effects are not significant as only female with secondary education have significant shorter waiting time. Second, the magnitude of the effects is again about 1,5 – 2 days shorter waiting time with supply side factors explaining about 25 % of the gradient.

Table 6. Waiting time in days from consultation to admission (indirect way)

	1	2	3	4
	Male		Female	
Primary education	Reference category			
Secondary education	-1.738 (-1.07)	-0.856 (-1.07)	-1.946 (-2.94)	-1.466 (-2.18)
Tertiary education	-0.258 (-0.28)	-0.667 (-0.69)	-0.936 (-1.34)	-0.806 (-1.12)
Health sector fixed effects*	No	Yes	No	Yes
R^2	0.110	0.177	0.128	0.183
N	87 866	86 673	128 920	127 870

t-statistics clustered at patient level reported in parentheses,
All regressions include fixed effects for year, age, medical discipline, and DRG
*Hospital, Distance, GP

3.2 *The effects of aggregation on the waiting times gradients*

To analyze the effects on the waiting time gradients of aggregation we measure socioeconomic status as shares of the inhabitants with different education or income level either in the patient's home municipality or at the GP where the patient is listed. We include the same control variables in the analyses of the individual level data except that we drop the GP fixed effects (there is no variation at the higher aggregation levels) and the travel distance variables (which are strongly correlated with the municipal income level). For comparison, the results with socioeconomic status measured at the individual level are also included.[15] In addition we adjust the standard errors to account for the clustering of units.

The next table provides information about the socioeconomic variables aggregated to the GP or the municipal level.

[15] The results are slightly different from the ones presented in table 2 since the GP fixed effects are dopped.

Table 7. Shares of education levels and income

	Individual	GP level	Municipality level
Male patients (172 384 admissions)			
Number of unique observations	172 384	13 412	1 236
Share with secondary education (standard deviation)	0.506	0.500 (0.226)	0.544 (0.107)
Share with tertiary education (standard deviation)	0.251	0.304 (0.152)	0.212 (0.071)
Average income (10^5 NOK) (standard deviation)	5.29 (4.87)	5.39 (1.15)	4.97 (0.71)
Female patients (222 844 admissions)			
Number of unique observations	222 844	13 556	1 236
Share with secondary education (standard deviation)	0.417	0.415 (0.195)	0.467 (0.092)
Share with tertiary education	0.345	0.400 (0.145)	0.338 (0.066)
Average income (10^5 NOK) (standard deviation)	3.28 (2.30)	3.78 (0.56)	3.58 (0.26)

From the table we see that the share of inhabitants with tertiary education is higher at the GP level than the individual level or the municipality level. This holds true for both sexes. Average income for men is lowest at the municipal level and slightly higher at the GP level compared with the individual level. For female, the pattern is different as average income is lowest at the individual level and highest at the GP level.

The next table show the results of the different aggregation levels on the socioeconomic gradient in waiting time.

Table 8: Effect of education on total waiting time (in days)

	1	2	3	4	5	6
	Male			Female		
Primary education	Reference category					
Secondary education	-2.12 (-3.22)	-16.96 (-2.89)	-11.09 (-0.68)	-2.98 (-4.90)	-14.77 (-2.18)	-17.26 (-0.69)
Tertiary education	-4.27 (-5.53)	-12.59 (-2.91)	-10.51 (-0.94)	-5.20 (-8.16)	-19.97 (-4.65)	-27.45 (-1.97)
Aggregation level	Individual	GP	Municipality	Individual	GP	Municipality
R^2	0.2099	0.2094	0.2098	0.2260	0.2260	0.2259
N	168 277	162 795	168 277	218 880	212 818	218 880

t-statistics clustered at the GP or municipal level reported in parentheses.

All regressions include fixed effects for year, age, medical discipline, DRG, and hospital

A comparison of the results to the those obtained when socioeconomic status is measured at the individual level shows that the coefficients are much higher when socioeconomic status is measured at an aggregated level. For example, the effects of tertiary education for female (male) compared to the individual level effect are about 5,2 (2,5) times higher. Comparing the coefficients of the two aggregation levels, we see that although the coefficients are lowest (highest) at the GP level for female (male), the coefficients are similar in magnitude. The main effect seems to be the departure from the individual level, not which level one departs to.

Turning to the question of whether the effects are significant we see that the level of aggregation matters. That is, the effects of socioeconomic status on waiting time are significant when socioeconomic status is aggregated to the GP level. The effects lose their significance when socioeconomic status is aggregated to the municipal level, the exception being female with at least one year of tertiary education that still is significant.

4. Discussion

We have investigated whether socioeconomic status, measured by education and income, affects waiting time when we control for patients' diagnosis, medical specialty and for factors shaping the supply of health services faced by the patients. The factors include patients' GP and hospital fixed effects. Socioeconomic status is matched at the individual level with individual-level administrative patient data. Our data also allow us to investigate where and how the socioeconomic gradient originates as we can decompose the gradient on different pathways into the hospital. Finally, by comparing the gradients in waiting time when socioeconomic status is measured at different aggregation levels, we provide insight into the effects of using aggregated data to the question of how individual socioeconomic status affects waiting times.

Our key findings are. The socioeconomic inequalities in waiting times are relatively modest compared with the usual findings in the literature, (Siciliani, 2016) as we find that the total effect is about a 3-4% reduction in waiting time for those with highest socioeconomic status relative to those with lowest socioeconomic status. The effects are similar for both sexes. Furthermore, all pathways into the hospital contribute to inequalities, but the main effects are through an increased probability of 2-3 percentage points of being admitted through the direct pathway, that is the admission into the hospital is direct and without first visiting an outpatient clinic. Again the results are similar for both sexes. For all analyses the gradients are dampened, and sometimes not significant, when factors shaping the supply of health services faced by the patients are controlled for.

Turning to the effects of different aggregation levels for the socioeconomic gradients we measure the socioeconomic status as sex specific shares of the inhabitants with different education or income level either at the GP where the patient is listed or in the patient's home municipality. Comparing the results to the analyses with individual level socioeconomic data, we find much larger effects of the socioeconomic variables and that aggregation in itself affects the results more than what level one aggregates to. More specifically, comparing the coefficients of the patients with the highest socioeconomic status with those with the lowest, we find that the coefficients are about 2 (5) times higher for men (women) when the socioeconomic variables are aggregated to either the GP or the municipal level. The standard errors are also higher than the in the analyses based on individual level socioeconomic data and differs for the two aggregation levels. The cruder the aggregation are the larger the standard errors. We find few significant effects when socioeconomic data are aggregated to the municipal level and hospital fixed effects are included. In conclusion, our results mimic the socioeconomic inequalities commonly found in the literature. A researcher who only has access to the aggregate data could easily interpret the magnitude of the gradients and the significant levels as within the expected range and conclude that the estimated (aggregate) gradients are reasonable.

A novelty with our analyses is that we can provide insight into where and how the socioeconomic gradient originate. Specifically we find that that patients with higher socioeconomic status have a higher probability of being admitted to the pathway with the lowest waiting time (the direct pathway). One mechanism behind this result is that patients with higher socioeconomic status are better able to communicate the disease symptoms to the GP, a result which is observed in the systematic review by (Willems et al., 2005). If the GP has more accurate information about the disease, the need for an outpatient consultation to collect more information might be lower, and hence the patient is admitted directly to an inpatient/day care stay.

Rationing of health care services characterize most health care systems. Rationing is either by co-payments or waiting times. An often cited benefit of rationing with waiting time is that it fulfills the goal of equal access to care for patient in equal need. However a recent health economics literature challenges this conclusion as it finds a relatively large socioeconomic gradient is waiting times for the specific procedures and treatments that are investigated. We believe that the question of whether rationing with waiting time fulfill the goals of equal access is best analyzed by investigating a broad set of hospital services. Furthermore, we believe that waiting time policies should be evaluated with individual level data on socioeconomic status to remove any possible aggregation bias. Based on our analyses we conclude that there is a socioeconomic gradient in waiting times for (somatic) hospital services in Norway. However the magnitude of the gradient is relatively modest compared with the usual findings in the literature. However, as we are unable to control for unobserved factors (e.g. patients' and their family members' health literacy) that maybe associated with both waiting time and socioeconomic status, we are cautious to interpret our findings as causal.

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Table A1: Effect of income on total waiting time (in days)

	1	2	3	4	5	6
	Male			Female		
Lowest income quartile	Reference category					
2nd income quartile	-2.98 (-4.11)	-13.55 (-1.72)	10.86 (0.47)	-1.20 (-1.86)	11.06 (1.42)	-6.01 (-0.16)
3rd income quartile	-3.75 (-9.95)	-22.82 (-3.42)	-15.37 (-1.00)	-3.40 (-5.11)	-6.93 (-1.03)	-19.19 (-0.86)
Highest income quartile	-5.87 (-7.40)	-20.26 (-4.01)	-11.85 (-0.91)	-6.40 (-9.20)	-19-94 (-4.15)	-31.97 (-1.62)
Aggregation level	Individual	GP	Municipality	Individual	GP	Municipality
R^2	0.2091	0.2088	0.2098	0.2255	0.2255	0.2253
N	171 587	165 874	171 587	222 162	215 853	222 162

t-statistics clustered at the GP or municipal level reported in parentheses.
All regressions include fixed effects for year, age, medical discipline, DRG, and hospital
The income variable on the GP and municipality level is the share of inhabitants with income in the specific quartile.