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WAITING TIME AND SOCIOECONOMIC STATUS—AN INDIVIDUAL-LEVEL ANALYSIS

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ABSTRACT

Waiting time is a rationing mechanism that is used in publicly funded healthcare systems. From an equity viewpoint, it is regarded as preferable to co-payments. However, long waits are an indication of poor quality of service. To our knowledge, this analysis is the first to benefit from individual-level data from administrative registers to investigate the relationship between waiting time, income, and education. Furthermore, it makes use of an extensive set of medical information that serves as indicators of patient need. Differences in waiting time by socioeconomic status are detected. For men, there is a statistically highly significant negative association between income and waiting time, driven by men in the highest income group, which constitutes 12% of all men. More educated women, that is, those having an education above compulsory schooling, experience lower waiting time than their fellow sisters with the lowest level of education.

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KEY WORDS: waiting time; socioeconomic status; equity; elective treatment; quality of care

1. INTRODUCTION

Waiting time is a rationing mechanism that is used in many healthcare systems. From an equity viewpoint, it is regarded as preferable to co-payments because the latter will exclude patients in need of treatment if they cannot afford it. However, waiting time causes pain, discomfort, and anxiety to the individual patient, and prolonged waits are an indication of poor quality of service. Despite the great political interest in avoiding waiting time and the concern for equity, little is known about the distribution of waiting time with respect to socioeconomic status (SES). The scarcity of empirical evidence on this topic is due to lack of high quality data. In a recent article, Siciliani and Verzulli (2009) applied survey data from nine countries to investigate the matter. For nonemergency surgery, they found a negative and significant association between education and waiting times in Sweden, The Netherlands, and Denmark, whereas the estimated effect of income was generally small. An advantage of survey data is that income information is at the individual or household level. However, morbidity may be measured with error such that the severity of illness is underestimated for poorer individuals (Propper *et al.*, 2005). Other drawbacks of survey data, such as small sample size and recall bias, have been pointed out in several yet unpublished analyses that use administrative data instead (Laudicella *et al.*, 2010; Carlsen and Kaarboe, 2010; Tinghög *et al.*, 2010; Sharma *et al.*, 2011). The contribution of this analysis is twofold: first, we used individual-level data from reliable sources, which enables us to explore the distribution of waiting time in great detail. The individual-level data stem from administrative registers. In that respect, our article is closest to the work of Tinghög *et al.* (2010), but our data set is larger. It includes information on supply-side factors and notably on education as well as income. Our analysis focuses on one patient group, thus enabling us to control extensively for

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patient severity. This is crucial as healthcare policy in many countries mandates shorter waiting times for more severely ill patients (Siciliani and Hurst, 2005) and because severity is typically correlated with SES. Second, the analysis investigates a setting where sample selection bias due to a private sector option is not a concern. If not taken into account, such sample selection leads to an overestimation of the association between waiting time and SES, as argued by Sharma *et al.* (2011). In this article, the patient population studied is patients who had a primary hip replacement in Norway during the years 2000–2003. Hip replacements in Norway are all financed by the compulsory insurance scheme, unlike the situation in for instance the UK or Australia.

The article is organized as follows. Section 2 provides some theoretical background. Section 3 gives a short description of the Norwegian healthcare system. Section 4 presents the data used, and the empirical method is explained in Section 5. Results are reported in Section 6 and discussed in Section 7. Section 8 concludes the article.

2. THEORETICAL BACKGROUND

In economic theory, waiting time is seen as a rationing device used in healthcare systems where there is a tax-financed insurance and a global budget on expenditure (Cullis *et al.*, 2000). Administered waiting lists ration demand because they impose various elements of costs to the individual. First, the expected health improvement from treatment is worth less when received later rather than sooner (Lindsay and Feigenbaum, 1984). Second, there is a disutility from the wait per se because the individual has to endure a worse health state while waiting (Propper, 1995). Third, if the individual's health status deteriorates while waiting, the outcome of treatment could be harmed.

There are several mechanisms through which waiting time can affect demand at public hospitals. For many treatments, a private sector option exists, which typically attracts patients by offering treatment at virtually no waiting time (Besley *et al.*, 1999). Patients could switch to an alternative treatment with less or no waiting time, for example, physiotherapy or pharmaceuticals (Siciliani and Iversen, 2012). Cullis *et al.* (2000) pointed out, however, that for a large majority of patients, it is not economically rational to avoid the costs of waiting for surgery. To reduce overall waiting time, some countries have introduced patient choice of provider in their public hospital sector. Within such a framework, patients with a high valuation of treatment will be more willing to trade-off travel costs for shorter waiting time (Brekke *et al.*, 2008).

The observed waiting time is the result of the interplay between demand and supply. Martin and Smith (1999) argued that waiting time affects supply because it enters into the utility function of key decision makers at hospitals, for whom waiting time is a performance indicator. Although there are reasons to maintain long waiting lists in a system with soft budget constraints (Iversen, 1993), waiting times are often used as targets, which could impose financial or nonfinancial penalties on the hospital. Another motivation to keep waits low could be altruism (Siciliani and Iversen, 2012).

What does the theoretical literature predict about the relationship between SES and waiting time? Besley *et al.* (1999) showed that individuals with low income are least likely to exit the queue by purchasing private insurance, assuming that a sick individual have preferences over quality of treatment (including waiting time) and income, that the utility function is concave in income, and that quality is a normal good. In a model where waiting time and distance are the key hospital competition parameters, Brekke *et al.* (2008) noted that differences in gross valuations across patients can be due to differences in age, gender, illness severity, or simply opportunity costs. Thus, because of higher opportunity costs, we generally expected high SES individuals to be more likely to be part of the competitive segment obtaining lower waits. Education is assumed to raise productivity, thereby increasing foregone labor income while waiting (Grossman, 1972). Income can have a separate effect on opportunity costs because high income implies a greater possibility set of consumption and good health can be seen as a prerequisite for enjoying other activities. An additional effect of education is that it can make an individual more informed about the healthcare system, lower search costs, or facilitate communication with medical personnel.

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Thus, economic theory points to demand side factors when explaining a socioeconomic gradient in waiting times, while it is—implicitly or explicitly—assumed that hospitals are not allowed or able to discriminate between different patient types with respect to waiting times. High SES patients are predicted to have a higher willingness to pay for lowering waits. Whether and how they obtain it depends on the institutional setting. However, for empirical research, it is a challenge that the individual patient's benefit and costs of alternative treatments are unobserved. There is a concern that unobserved individual characteristics that are correlated both with SES and waiting time may create an omitted variable or selection bias.

3. INSTITUTIONAL FRAMEWORK

Norway's healthcare system is largely financed by general taxes. Most services are nearly free of charge at the point of usage, and this applies to elective hip operations. The large majority of inpatient treatment takes place at public hospitals. The private commercial involvement in this sector is negligible, and private health insurance was nonexisting during the study period. For historic reasons, there are quite a few not-for-profit private hospitals operating, some of which have specialized in elective surgery. Total hip replacements are carried out by most Norwegian hospitals, but the number of operations per year varies significantly among them.

Our sample entails patients who entered the waiting list in 1999–2003. Before 2002, public hospitals were owned by 19 different counties. Pursuant to the hospital reform implemented on January 1, 2002, the specialized healthcare sector was organized as state-owned enterprises within five regional health authorities. From 1997 onwards, hospital owners have been given economic incentives to attract patients because part of their funding—varying over time—is based on activity level. The rest is given as a block grant.[1]

As of 1 January 2001, Norwegian patients have been granted a legal right to choose a provider for elective treatment.[2] Before this reform, 7 of 19 counties had run a pilot project, although with a restricted right to choose provider. It did not include university hospitals, and in most cases, it was confined to the county of residence. Overall, the allocation of patients to hospitals was determined by the referral patterns of individual general practitioners (GPs) and county borders, and patients were usually referred to the closest hospital (Ot.prp. nr. 12, 1998–99). In Norway, patients may have to travel long distances to hospital; however, copayment for transportation is negligible.[3] Information on waiting times was available via a free telephone service, which started when the reform was implemented in 2001.[4] Despite the free choice of provider, only 1% of the patients in 2003 and 2004 actually opted for elective treatment at hospitals outside their own health region, according to Christensen and Hem (2004).

Patients who undergo elective surgery are referred to a hospital by a GP, who in his/her referral letter gives a description of the patient's medical condition. To assess whether a hip replacement, for example, is necessary, an examination is typically conducted by an orthopedic surgeon at an outpatient clinic. The referral entails the patient being placed on a waiting list at a particular hospital. Prioritization should be based on three criteria: the degree of severity, the expected efficacy of treatment, and the cost in relation to the expected outcome of the treatment (see Askildsen *et al.*, 2011). These general criteria have to be operationalized. It was not until Sept 1, 2004, that is, outside the scope of this analysis, that each patient was given an individual maximum waiting time. While waiting, the patient may choose to switch to another hospital but will then be treated as a newcomer to the latter hospital's waiting list, so there is, in effect, a certain lock-in mechanism at play. Waiting time is defined as the time elapsed between referral and the date of hospitalization.

[1]The proportion of funding that is activity-based was 50% of the stipulated cost per diagnosis-related group (DRG) in 1999–2001, 55% in 2002, and 60% in 2003.
[2]The right extends to all public hospitals in the country as well as to noncommercial hospitals that have an agreement with hospital authorities, that is, the private hospitals in this analysis.
[3]The copayment was the equivalent of 27 euros one way if the patient goes to a hospital in another health region and about 16 euros otherwise (payment data from 2005).
[4]In May 2003, the government launched an information service on the Internet. This study uses data for patients who entered onto the waiting list no later than June 2003.

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The GP is likely to be better informed than the patient about the overall quality of different hospitals. As a result of the reform introduced on June 1, 2001, every Norwegian citizen is entitled to a specified GP, who is allocated a key role as advisor when patients choose a hospital. Most GPs are self-employed, and they are financed partly by list patient capitation and partly by fee-for-service. It is difficult to see what self-interest a GP should have in making referrals to a specific hospital, except for possible loyalty and personal relations. Gathering information is time consuming and therefore costly to him (Vrangbæk *et al*., 2007). GPs get no direct compensation for such services, but the competition for patients introduced by a list patient system may have given them stronger incentives to engage in the matter (Carlsen *et al*., 2005).

4. DATA

4.1. Construction of the data set

The data set is a pooled cross section obtained by merging data from four different sources. Details on these data sets and the exclusion criteria are shown in the following paragraphs.[5]

The source data are from the Norwegian Arthroplasty Register (hereafter NAR). Registrations in NAR are voluntary and based on registration forms that the surgeon completes immediately after an operation. Both public and private hospitals report to the register, which had a reporting rate of 98% of all hip replacements in 1999–2002 (Espehaug *et al*., 2006). This analysis uses data on elective primary hip replacement operations performed at Norwegian hospitals during the period 2000–2003 on patients 25 years of age or older. If an individual has had several primary hip operations during the study period (i.e. on both hips), only the first one is included. Thus, 22,771 operations performed on the same number of individuals are relevant for this analysis. NAR provides data on the date of operation, the hospital used, patient's age and gender, and extensive medical information specifically related to the hip replacement. In addition to main diagnosis and number of secondary diagnosis, we included variables that reflect the patient's history of hip operations over a long period; indicators for having had any hip operation before the hip replacement and for having another primary hip replacement after the one in question. Furthermore, there are indicators representing the medical reason for the primary hip replacement observed.

Data on the individual's level of education, income, number of children, and marital status have been gathered from registers at Statistics Norway. These registers can be perfectly merged with the NAR data using the unique personal identification code. Waiting time data are provided by the Norwegian Patient Register, and we used only observations that had NSCP codes relevant for primary hip replacements within DRG 209. For each hospital stay, there are data on the patient's waiting time and home municipality, the name of the hospital, whether the stay was an emergency case or not, procedures executed, main diagnosis, secondary diagnosis, and so on. A matrix of distances between all Norwegian municipalities provides information on driving distance by car in minutes and makes it possible to identify the closest and next closest hospital in relation to the patient's home municipality.

To construct the data set for analysis, data from the Norwegian Patient Register have been merged with the NAR data using the following variables: patient's year of birth, gender, date of operation, and hospital number. After matching, the combined data set consisted of 17,871 observations, which is 79% of the relevant part of the NAR data set.[6] Among these, 1434 observations lacked information on waiting time and 112 on the level of education. For fear of measurement errors, we have dropped observations that are outliers with respect to

[5]The Data Inspectorate and the Directorate of Health and Social Affairs have issued the concessions necessary to construct the data set.

[6]How well the two registers match varies among the institutions.We have investigated whether some institutions are strongly under- or overrepresented after the match compared with their share of operations in the NAR. Differences are traced, without any obvious explanation. The data set after matching is very similar to the prematching NAR set with respect to mean and variance of sex, age, and date of operation. One source of mismatch stems from the fact that bilateral hip replacements made during one hospital stay are counted as two observations with the NAR, but only one with the NPR.

[7]Outliers are defined in accordance with several other studies of waiting times in Norway (The Office of the Auditor General of Norway, 2003).

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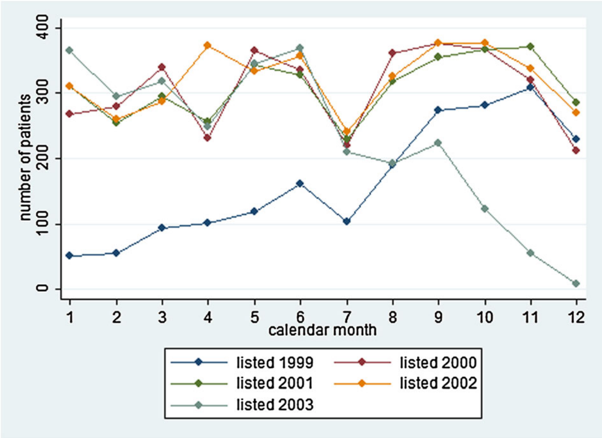

Figure 1. Entry to the waiting list, by calendar month and year, among patients having a primary hip replacement January 2000–December 2003.

waiting time, in total 497 observations.[7] After inspecting seasonal variation in entry onto waiting lists, we excluded 2436 observations where entry took place before November 1999 or later than June 2003 (see Figure 1). The procedure described above generates a data set of 13,348 individuals 25 years and older, treated at public or private noncommercial hospitals.

4.2. Descriptive statistics

Table I presents an overview of key variables and summary statistics by gender (for more comprehensive information on the data set, see Table A1, which reports for the mean individual). Waiting time varies substantially, with a mean of 174 days for men and 167 days for women. The dependent variable is defined as the log of waiting time.

The key explanatory variables are education and income. Education is represented by four binary indicators for levels of completed education: compulsory schooling, 1 or 2 years of secondary schooling, 3 years of secondary schooling, and some higher education (college or university).[8] Income is measured by yearly gross income, which comprises all income from labor, private enterprise, pensions, sickness allowance, and financial income. Yearly nominal income in Norwegian kroners (NOK), on which we have data for the years 2000–2003, is deflated to year 2000 price level, and we generated five dummies representing income intervals. As waiting time observed is the result of supply and demand, it is important to control for supply factors as well. These and other controls are presented in the Empirical Analysis section.

The reference individual is a never-married woman (man) who entered the waiting list in 1999 and whose highest level of education is compulsory schooling. Seventy percent of the patients are women, and their average age is 70 years, whereas men are, on average, 2.5 years younger. Women are heavily concentrated in the lowest income group, the proportion is 61% (men, 24%), and only 2% (men, 12%) belong to the highest income group. Women had a lower level of education as well: only 19% (men, 35%) had completed 3 years of upper secondary education or higher education. Because of restrictions made during data selection, only 4% of the sample entered the list in 1999, approximately 27% in each of the years 2000, 2001, and 2002, and approximately 14% in 2003. Of the sample, 23% of women (men, 21%) had surgery at a nonprofit private hospital and approximately 8% at a university hospital.

[8]For the younger part of the sample, compulsory school lasted 9 years. The definition of levels of secondary schooling takes into account the fact that the length of compulsory schooling has increased over time. Thus, it may be regarded as a measure of an individual's level of education relative to his cohort.

[9]Distance is measured from one municipality center to the other. Consequently, if the hospital used is located in the municipality where the patient lives, the distance will be zero.

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Table I. Descriptive statistics

	Men (4009 observed)		Women (9339 observed)	
	Mean	SD	Mean	SD
Waiting time (days)	173.7	135.6	166.7	127.6
Age when registered on waiting list	67.9	10.9	70.3	10.4
Income				
Gross income year ($t-1$), price deflated, NOK	275921	333923	156330	132247
Average gross income 2000–2003, price deflated, NOK	273179	333394	158827	127560
1 if income < 150 (1000 NOK)	0.24	0.42	0.61	0.49
1 if income 150–200 (1000 NOK)	0.21	0.41	0.17	0.37
1 if income 200–250 (1000 NOK)	0.17	0.37	0.10	0.30
1 if income 250–400 (1000 NOK)	0.26	0.44	0.10	0.30
1 if income > 400 (1000 NOK)	0.12	0.33	0.02	0.14
Education				
1 if compulsory schooling only	0.33	0.47	0.42	0.49
1 if 1 or 2 years of secondary schooling	0.33	0.47	0.38	0.49
1 if 3 years of secondary schooling	0.17	0.37	0.07	0.26
1 if higher education	0.18	0.39	0.12	0.33
Other key explanatory variables				
1 if registered on waiting list in 1999	0.04	0.21	0.04	0.19
1 if registered on waiting list in 2000	0.27	0.44	0.27	0.44
1 if registered on waiting list in 2001	0.27	0.44	0.27	0.45
1 if registered on waiting list in 2002	0.28	0.45	0.28	0.45
1 if registered on waiting list in 2003	0.13	0.34	0.14	0.35

The average distance to the hospital used was 1.24 h (men, 1.08 h) by car.[9] Travel distances within Norway may be substantial; in this data set, the maximum travel distance to the closest hospital is 7.7 h.

5. EMPIRICAL ANALYSIS

Economic theory predicts that waiting time affects both demand and supply (see Section 2). As is common in this type of analysis,[10] we estimated a reduced form, including as many variables as possible among those that we suspect affect supply, demand, or both. The reason is that in our data, the number of patients treated is accurately observed for each period, but we do not observe how many individuals are waiting or offered treatment at a given point in time. To investigate the relationship between SES and waiting time, we estimate an ordinary least squares (OLS) model, separately for men and women, as follows:

$$\mathrm{WT}_i = \beta_0 + \beta_1^{'}\mathrm{AGE}_i + \beta_2^{'}\mathrm{MAR}_i + \beta_3^{'}\mathrm{MED}_i + \beta_4^{'}\mathrm{TIME}_i + \beta_5^{'}\mathrm{LOC}_i + \beta_6^{'}\mathrm{HOSP} + \beta_7^{'}\mathrm{SES}_i + \varepsilon_i$$

where WT is the log of waiting time of individual i. The parameter vector of prime interest is β_7, connected to SES, which represents the level of completed education (by dummy variables) and income. Income is expressed either as the log of gross income the year before entry at waiting list or by dummy variables based on gross income. AGE represents a quadratic function of the patient's age when first registered on the waiting list, and MAR gives data on marital status and parenthood to children younger than 18 years. MED is a comprehensive vector of medical information, described in Section 3. Trends in waiting time are captured

[10]Notable exceptions are Martin and Smith (1999) and Martin *et al.* (2007), who estimate supply and demand models separately.
[11]Year dummies cover several aspects that are potentially important for waiting time, for example, health care sector reforms, technological change, hospitals' total budget, and the share assigned to activity-based financing.

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by the TIME vector, which contains data on the year in which the patient was placed on the list as well as calendar month.[11] The LOC vector comprises geographical information on county, regional health authority, and the patient's distance to the closest hospital as well as extra distance to the next closest hospital. Hospital-fixed effects are controlled for in the HOSP vector, which captures variation in capacity and efficiency across hospitals as well as general hospital reputation or loyalty between referring GPs and specific hospitals. Volume has been found to be an important indicator of quality in hip replacement (Losina *et al*., 2004).[12] In addition, an indicator for university hospital is included to reflect that the more complicated cases are typically treated there, as well as an indicator for (noncommercial) private hospital.

Our choice of estimator is facilitated by our waiting time measure being a continuous variable (see the discussion by Siciliani and Verzulli, 2009). However, waiting is a duration, and the distribution of days on the waiting list is heavily skewed to the right. Taking into account the fact that there are no zero values and no peaks in this distribution, we defined the dependent variable to be the logarithm of days waited and apply an OLS specification. Having performed this transformation, applying an OLS model is approximately equivalent to running a basic duration model (Carlsen and Kaarboe, 2010). Note that our data are at the individual level, which is very rare in the analysis of how waiting time varies by SES. Data on key variables are from administrative registers, thus reducing the risk of measurement error and avoiding small sample size, which is a concern in surveys. Furthermore, in this analysis, sample selection due to a private sector option is not an issue because the private hospitals included are part of public health plans, that is, treatment is covered by compulsory insurance.

We do not claim that this analysis reveals the causal effect of SES on waiting time. The possibility of endogeneity cannot be ruled out, for instance, due to unobserved characteristics that are correlated both with waiting time and SES. However, this potential problem is alleviated by our extensive set of control variables representing medical, demographic, and geographical information.

6. RESULTS

Our interest lies in the association between waiting time and SES, and the data available allow us to investigate whether this relationship differs by gender. Table II displays the results from estimating three different specifications. Columns labeled 1 and 3 report results from estimating the equation presented in the previous section, and the specification reported in column 2 focuses on the introduction of hospital choice. The base category is patients of no income whose highest level of completed education is compulsory schooling. Note that across specifications, a host of control variables are included but not reported for lack of space.[13]

Separating the sample by gender renders interesting results. Column labeled 1 indicate that well-off men wait shorter for treatment (a 10% increase in income is associated with a 7.8% decline in wait), whereas the level of education is insignificant. For women, the picture is quite the opposite. There is a clear negative association between the level of education and the waiting time, whereas the income variable is insignificant. In particular, women having 3 years of upper secondary education experience shorter waits compared with their fellow sisters with compulsory schooling only. It should be noted that an estimation on the whole sample, with control for gender, will disguise the gender difference in the association between SES and waiting time and thus lead to a misinterpretation of the results.

In columns labeled 2, we have investigated whether these associations are the same before and after the introduction of free choice of hospital. We replaced year dummies with an indicator that equals one if the patient entered the list in 2001 or later, and we included interaction terms between this indicator and the SES

[12]Hospital characteristics important for waiting time could be correlated with patient SES through area of residence, in which case hospital-fixed effects represent an extra control in addition to the LOC vector. As Sharma *et al*. (2011) point out, controlling for hospital-fixed effects allows for interpreting β_7 as indication of inequality within a hospital rather than across hospitals.

[13]Results not reported here in the paper are available from the authors upon request.

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Table II. Results—waiting time and SES (OLS)

	Men			Women		
	1	2	3	1	2	3
Log of income	−0.078 (−3.53)***	−0.091 (−2.08)**		0.009 (1.05)	−0.011 (−0.76)	
1 if income 150–200 (1000 NOK)			0.019 (0.50)			−0.005 (−0.20)
1 if income 200–250 (1000 NOK)			−0.014 (0.32)			−0.009 (−0.31)
1 if income 250–400 (1000 NOK)			0.028 (0.66)			−0.033 (−1.06)
1 if income >400 (1000 NOK)			−0.142 (−2.64)***			0.027 (0.46)
1 if 1 or 2 years of secondary school	−0.007 (−0.22)	0.009 (0.17)	−0.020 (0.62)	−0.048 (−2.66)***	−0.002 (−0.07)	−0.044 (−2.38)**
1 if 3 years of secondary school	−0.006 (−0.15)	0.023 (0.31)	−0.025 (0.60)	−0.083 (−2.48)**	−0.107 (−1.72)*	−0.074 (−2.16)**
1 if higher education	−0.023 (−0.56)	−0.006 (−0.08)	−0.040 (−0.90)	−0.056 (−1.97)**	−0.067 (−1.35)	−0.041 (−1.33)
Interaction terms with hospital choice options:						
Log of income		0.009 (0.17)			0.022 (1.28)	
1 if 1 or 2 years of secondary school		−0.037 (−0.53)			−0.074 (−1.89)*	
1 if 3 years of secondary school		−0.075 (−0.86)			0.009 (0.12)	
1 if higher education		−0.057 (−0.63)			0.002 (0.04)	
Other explanatory variables:						
1 if hospital choice option		−0.313 (−0.52)			−0.476 (−2.32)***	
Age when listed	0.003 (0.30)	0.004 (0.36)	0.001 (0.06)	0.011 (1.39)	0.011 (1.42)	0.011 (1.42)
1 if multiple PHRs within study period	−0.263 (−6.02)***	−0.216 (−4.86)***	−0.263 (−6.02)***	−0.179 (−6.56)***	−0.135 (−4.84)***	−0.179 (−6.57)***
1 if prior hip operation	0.129 (1.81)*	0.115 (1.58)	0.129 (1.81)*	0.047 (1.09)	0.046 (1.06)	0.046 (1.08)
No. secondary diagnoses	0.015 (1.30)	0.006 (0.51)	0.016 (1.38)	0.041 (5.77)***	0.031 (4.25)***	0.041 (5.75)***
1 if registered on waiting list in 2000	−0.194 (−2.72)***		−0.197 (−2.77)***	−0.192 (−3.95)***		−0.191 (−3.92)***
1 if registered on waiting list in 2001	−0.281 (−3.93)***		−0.283 (−3.96)***	−0.264 (−5.45)***		−0.262 (−5.41)***
1 if registered on waiting list in 2002	−0.417 (−5.81)***		−0.422 (−5.87)***	−0.435 (−8.89)***		−0.433 (−8.83)***
1 if registered on waiting list in 2003	−0.853 (−10.56)***		−0.857 (−10.60)***	−0.838 (−15.57)***		−0.834 (−15.50)***
1 if treated at private hospital	−0.558 (−5.33)***	−0.393 (−3.72)***	−0.570 (−5.43)***	−0.433 (−6.38)***	−0.304 (−4.42)***	−0.430 (−6.34)***
1 if treated at university hospital	0.954 (1.17)	0.508 (0.61)	0.898 (1.10)	−0.152 (−0.82)	−0.341 (−1.80)*	−0.148 (−0.80)
Distance to closest hospital	0.006 (0.24)	0.002 (0.08)	0.006 (0.23)	0.027 (1.66)*	0.030 (1.79)*	0.027 (1.64)
N	3943	3943	3943	9223	9223	9223
R^2	0.229	0.197	0.229	0.239	0.204	0.238

Data in parentheses are *t* statistics. In specifications 1 and 2, income is expressed by its logarithm; in specification 3, income is expressed by income dummies. Model 2 includes a dummy for having the option of hospital choice, which is interacted with SES variables. The reference category patient in specification 3 has an income less than 150,000 NOK; no education above compulsory schooling and was registered at the waiting list in 1999. Included in all specifications are hospital-fixed effects, marital status, a dummy for having children younger than 18 years, a full set of indicators for 19 counties, 5 regional health authorities, 8 reasons for hip replacement, 12 main diagnosis, dummies for calendar month of entry to waiting list, and a constant term.
*$p < 0.10$,
**$p < 0.05$,
***$p < 0.01$.

variables. The situation before the reform is expressed through the coefficients of SES variables in level form. The estimates show that among men, waiting time decreased significantly in income in that period as well. Among women, patients with 3 years of upper secondary schooling seem to experience less waiting time, although the difference is at a low level of significance.

The estimated change in waiting time for the base category is large (coefficients of −0.313 and −0.476), as expected given the downward trend shown by the year dummies in column 1.[14] Our prime interest lies in the interaction terms, which show the additional change in waits for patients of higher SES compared with the baseline category. There is some indication that women with 1 or 2 years of upper secondary schooling experience a larger decrease in waits than their fellow sisters with compulsory schooling only. The general picture is, however, that the change in waiting time from the pre- to the post-reform period does not differ by SES. Thus, while waiting time has fallen, the social gradient found before the reform persists.

Having found a negative relationship between income and waiting time for men in column 1, we want to inspect this further by replacing the log of income with income dummies. The results in column 3 of Table II show that the negative association is linked solely to men in the highest income category. Other things being equal, a man in this income category (top 12% of all men) waits, on average, 25 days shorter than a man in the lowest income group (bottom 24%). Education above compulsory schooling decreases waiting time for women, in a nonlinear manner. Women with the shortest estimated waiting time, that is, those who have completed 3 years of secondary schooling, wait 12 days less than their fellow sisters with compulsory schooling only. With better control for income, the indicator for higher education is, although still negative, no longer statistically significant.

Results for other control variables can be summarized as follows: hospital-fixed effects are included in all specifications, and many of them are large and strongly significant. Inspecting patient characteristics, we find that patients who have a primary hip replacement on both hips during the study period constitute a special group who experience considerably shorter waits for the first of the two operations. After inclusion of an extensive set of controls, patient age is insignificant. For women, waiting time increases in the number of comorbidities, which is surprising, and men who have had a hip operation before the hip replacement (8% of all men) wait 13% longer. For both genders, the main diagnosis and the medical reason for hip replacement are major determinants of waiting time. Indicators representing county or regional health authority are also important. While controlling for these variables, we do not report their coefficients to keep the presentation simple.

Because the unconditional distribution of waiting time is heavily skewed to the right, we may suspect that results are driven by a few individuals having very high waiting time. Therefore, we have checked whether the association between SES and waiting time is the same across different segments of the conditional waiting time distribution. Results from quantile regression are presented in Table III.

To allow quantile regression models to converge, we simplify the specification by excluding hospital-fixed effects. Otherwise, the specification estimated is the same as in column 3 of Table II. Quantile regression results confirm to a large extent the picture given for the mean individual in Table II: At the median waiting time, men in the highest income category and women having 1–2 or 3 years of upper secondary education experience significantly shorter waiting time. The magnitude is very similar to OLS estimates for women and somewhat lower for men. Interestingly, at median conditional values of waiting time, education reduces waiting time for men as well, by 9%–10% for men with at least 3 years of upper secondary education compared with men with compulsory schooling only. Although more education seems to be associated with avoiding above median waits among women (at 70% and 90% quantile), belonging to the highest income category is linked to experiencing below-median waits among men (at the 30% quantile). Quantile regression reveals that women in the highest

[14]Column 1 shows that men registered on the list in 2003 experience an 85% shorter wait than men registered in the base year 1999, other things being equal.

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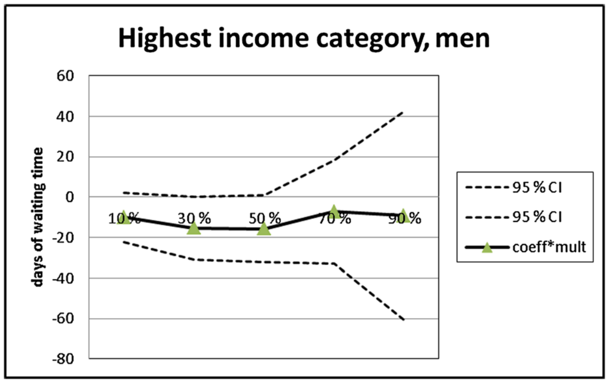
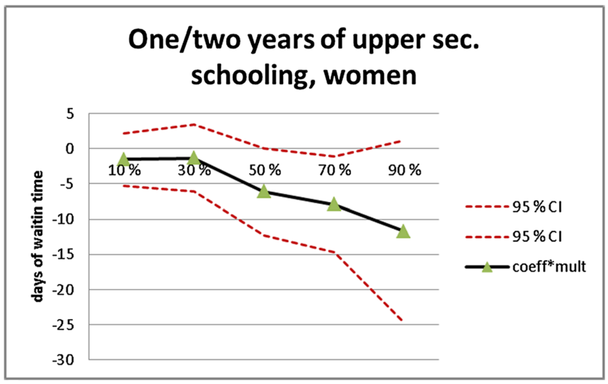
Table III. Quantile regression—waiting time and SES

	10%	30%	50%	70%	90%
(a) Men					
1 if income 150–200 (1000 NOK)	0.095 (0.086)	−0.002 (0.056)	−0.026 (0.041)	−0.019 (0.045)	0.020 (0.056)
1 if income 200–250 (1000 NOK)	−0.022 (0.096)	−0.055 (0.063)	0.013 (0.045)	0.021 (0.050)	−0.016 (0.063)
1 if income 250–400 (1000 NOK)	0.046 (0.096)	−0.040 (0.062)	−0.013 (0.045)	0.016 (0.049)	0.054 (0.059)
1 if income >400 (1000 NOK)	−0.192 (0.120)	−0.151 (0.078)*	−0.105 (0.057)*	−0.035 (0.063)	−0.028 (0.079)
1 if 1 or 2 years of secondary education	−0.068 (0.073)	−0.075 (0.047)	−0.054 (0.034)	0.019 (0.038)	0.045 (0.048)
1 if 3 years of secondary education	−0.042 (0.094)	−0.076 (0.061)	−0.102 (0.044)**	−0.076 (0.049)	0.006 (0.062)
1 if higher education	−0.075 (0.103)	−0.039 (0.066)	−0.091 (0.047)*	−0.073 (0.052)	0.064 (0.065)
(b) Women					
1 if income 150–200 (1000 NOK)	−0.062 (0.048)	0.018 (0.030)	−0.013 (0.027)	−0.003 (0.022)	−0.058 (0.027)**
1 if income 200–250 (1000 NOK)	−0.085 (0.059)	−0.015 (0.038)	−0.014 (0.035)	−0.021 (0.028)	0.027 (0.034)
1 if income 250–400 (1000 NOK)	−0.095 (0.066)	−0.009 (0.041)	−0.023 (0.037)	−0.019 (0.030)	−0.020 (0.036)
1 if income >400 (1000 NOK)	−0.036 (0.121)	−0.016 (0.075)	0.039 (0.069)	−0.001 (0.056)	0.276 (0.070)***
1 if 1 or 2 years of secondary education	−0.031 (0.038)	−0.014 (0.024)	−0.043 (0.022)*	−0.040 (0.018)**	−0.038 (0.022)*
1 if 3 years of secondary education	−0.106 (0.070)	−0.070 (0.044)	−0.071 (0.040)*	−0.062 (0.032)*	0.018 (0.039)
1 if higher education	−0.011 (0.064)	−0.000 (0.039)	−0.050 (0.036)	−0.081 (0.029)***	−0.016 (0.035)

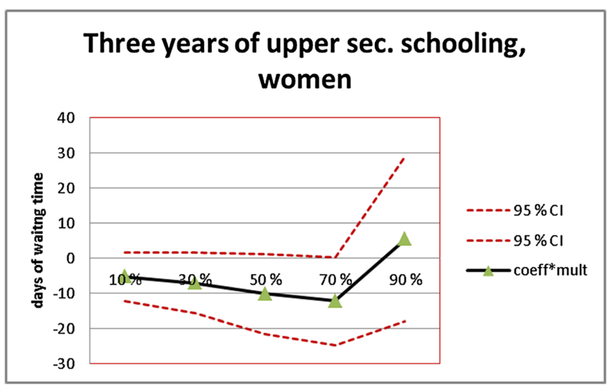
SE are shown in parentheses. The table shows results from quantile regression of the 10th, 30th, 50th, 70th, and 90th conditional percentiles of log of waiting time. For control variables included but not reported here, see notes to Table II. The specification estimated is the same as in column 3 of Table II, except that hospital-fixed effects are not included here.
*$p < 0.10$,
**$p < 0.05$,
***$p < 0.01$.



a



b



c

Figure 2. (a)-(c). Average marginal effect of SES variables on days of waiting time across quantiles. The solid line shows the product of the coefficient from quantile regression and a multiplier, as explained by Cameron and Trivedi (2009).

income group often wait for a very long period, in the 90% quantile. This category constitutes only 2% of all women, see Table I.

Figures 2a–2c illustrate the association between SES and waiting time over the five conditional quantiles, for SES variables for which it has been found statistically significant in Table II, column 3. The dependent variable is on logarithmic form, so instead of plotting coefficients and their confidence interval, we have converted this into days of waiting time (Cameron and Trivedi, 2009, p. 211). Figures 2a–2c illustrate that variation in waiting

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time associated with SES can be substantial, particularly at high quantiles. We comment on quantiles for which the association has been found to be statistically significant at 10% level or less in Table III. At the 30% and 50% quantile, men in the highest income category experienced 15 days of shorter waits compared with men in the lowest income group. Similarly, women with 1–2 years of upper secondary education have 6, 8, or 12 days of shorter waits at the 50%, 70%, and 90% quantile, whereas women with 3 years of upper secondary education have, on average, 10 or 12 days of shorter waits at 50% and 70% quantile, respectively.[15]

7. DISCUSSION

Our results contrast the findings by Siciliani and Verzulli (2009), who conclude that “Surprisingly, an increase in income of 10,000 Euro increases waits by 11% in Sweden.” There are many differences between the two studies. Nevertheless, in many respects, the Norwegian healthcare system bears similarities to the Swedish, and the average age is not very different in the two analyses (65 versus 69 years). With more detailed and reliable data and a larger sample, we find a negative relationship between waiting time and SES in Norwegian data.[16] Furthermore, our study shows that this relationship is gender-specific. Carlsen and Kaarboe (2010) also separated the analysis by gender and found a pro-educational bias for women and essentially no association between income and waiting time for either gender. Their analysis is at a population cell level and for numerous diagnoses. Income and education are included in separate regressions, which is a drawback given the high correlation between the two variables. Our analysis of individual-level data, where education and income are included simultaneously, reveals that there is a statistically significant association between income and waiting time for men, and it supports their finding of a pro-educational bias for women.[17]

The difference in our results by gender may possibly be explained by the fact that household income is unobserved. We control for marital status and for having children younger than 18 years, but this may be an imperfect proxy for household income. The correlation between personal income and household income is generally known to be much stronger for men than for women, as well as the correlation between personal income and education, which can be observed in our sample. The underlying reason is the division of earned labor and household work between the genders; women have lower labor market participation, more often hold part-time jobs, and are concentrated in the public sector where the wage level is more compressed. Gender differences in labor income lead to gender differences in pension income, and the latter is particularly relevant for our sample.

A caveat should be made that the exact mechanisms behind the negative association between SES and waiting time cannot be unraveled in this analysis. However, in this case, some factors that are commonly associated with inequality in healthcare can be excluded. First, given the age composition of the sample, patient’s labor market association when they enter the waiting list is not likely to be important.[18] Second, private health insurance or use of private hospitals outside the national health plan was not an issue during the period studied. This is important as it rules out the potential sample selection bias found in a recent study

[15] As can be seen from the figures, the upper limit of the 95% confidence interval is positive at some of the percentiles mentioned earlier (the maximum positive value is 1.14 days), implying that the change is not significant at 5% level. For details, see significance levels in Table III.

[16] Note that the study by Siciliani and Verzulli (2009) lacks control for supply side factors, which proves to be of major importance in our analysis as well as in Carlsen and Kaarboe (2010).

[17] Tinghög *et al.* (2010) apply individual-level data as well but do not separate their analysis by gender. Neither education nor supply side variables are included, which makes it difficult to compare their results to ours. They find that low disposable household income predicted longer waiting times for orthopedic surgery in a Swedish county in 2007.

[18] As much as 78% of the men and 84% of the women in the sample are older than 60 years, which approximates the average age of withdrawal from the Norwegian labor market.

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by Sharma *et al*. (2011). However, we cannot rule out the possibility that self-selection takes place for other reasons. As discussed in Section 2, economic literature suggests that high SES patients will be more willing to trade-off travelling for shorter waits, when given the chance. Indeed, this is a finding in our previous work, where education is used as a proxy for SES (Monstad *et al*., 2006). It is tempting to view the implementation of the 2001 free choice of provider reform as an exogenous source of variation in the degree of self-selection. However, our simple before/after setup reported in column 2 of Table II should not be considered an evaluation of this reform with respect to social inequality in waiting time because it is not possible to isolate the effect of the reform from other potentially important institutional changes.[19] Our estimations show a negative association between waiting time and SES both before and after the provider choice reform.

A possible mechanism, in line with human capital theory, could be that education makes patients more apt in acquiring information about the functioning of the healthcare system. However, we find no statistically significant association between waiting time and education in the male sample, controlling for income. An alternative explanation, which seems reasonable, is that unobserved factors correlated with income and education influence on waiting time. For instance, better-off and/or more educated individuals may have lower search costs because of better informed networks. They may be more demanding and persistent patients who make an extra call to the hospital to inquire about waiting time or have their GP do it. They possibly communicate better with healthcare personnel and are able to convince them about the need for a shorter wait.

8. CONCLUSION

The empirical literature on socioeconomic differences in waiting time is scarce, in contrast to the great political interest in waiting time and the declared health policy aim of "equal treatment for equal need." We claim that this analysis is a major contribution to the existing literature because of the data set applied. Having relevant and reliable data on SES and a comprehensive set of controls for medical condition is a prerequisite for undertaking such an investigation. This analysis, which benefits from individual level data from administrative and high-quality health registers, detects socioeconomic differences in waiting time. Our measures of SES are the level of education and gross income, which is available over several years. We find that higher SES is associated with lower waiting time both for men and women. For men, there is a statistically highly significant negative association between income and waiting time, whereas educational level does not seem important. More educated women, that is, having an education above compulsory schooling, experience lower waiting time than their fellow sisters with the lowest level of education. Quantile regression estimates at median values correspond well with OLS results and show that education has a separate influence on waiting time for men. The association estimated, with control for hospital-fixed effects, is of some magnitude. Compared with a woman with compulsory schooling only, a woman who has completed 3 years of secondary education experiences, on average, a 7.4% reduction in waiting time, which corresponds to a reduction of 12 days. Likewise, other things being equal, a man in the highest income category (top 12%) waits, on average, 25 days shorter than a man in the lowest income group (bottom 24%). This inequality is found in a setting where there is no sample selection due to a private sector option. The study design does not allow us to disentangle the exact mechanisms behind our results, and the associations found should be interpreted with caution. It could be that education helps when interacting with the healthcare system. Another plausible explanation is that unobserved characteristics that are correlated with socioeconomic status have an impact on waiting times.

[19]In particular, we think of the pilot project which was in force several years before 2001, the introduction of the patient list system June 1, 2001, which changed the GP's role as a gate-keeper, and changes in financial incentives. The Norwegian provider choice reform does not offer a clearly defined control group, in contrast to the policy change studied by Dawson *et al*. (2007).

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APPENDIX A:

TABLE AI. DESCRIPTIVE AND SUMMARY STATISTICS

	Observed	Mean	SD	Minimum	Maximum
Dependent variable					
Waiting time (days)	13,348	169	130	2	994
Log of waiting time (days)	13,348	4.821	0.872	0.693	6.902
Age and gender					
1 if female	13,348	0.700	0.458	0	1
Age when registered on waiting list	13,348	69.626	10.586	25	98
Medical information					
1 if multiple PHRs within the period studied[a]	13,348	0.098	0.297	0	1
1 if prior hip operation	13,348	0.100	0.301	0	1
1 if reason for hip replacement is unspecified	13,284	0.026	0.161	0	1
1 if reason for hip replacement is spondyloarthrithis (Bechterew)	13,284	0.003	0.053	0	1
1 if reason for hip replacement is idiopathic osteoarthritis of the hip	13,284	0.784	0.412	0	1
1 if reason for hip replacement is rheumatoid arthritis	13,284	0.024	0.154	0	1
1 if reason for hip replacement is secondary to Perthes disease or slipped capital femoral epiphysis	13,284	0.012	0.107	0	1
1 if reason for hip replacement is secondary to developmental dysplasia of the hip	13,284	0.070	0.256	0	1
1 if reason for hip replacement is secondary to developmental dysplasia of the hip with dislocation	13,284	0.003	0.055	0	1
1 if reason for hip replacement is secondary femoral neck fracture[b]	13,284	0.078	0.268	0	1
1 if main diagnosis is M059	13,348	0.007	0.082	0	1
1 if main diagnosis is M160	13,348	0.219	0.414	0	1
1 if main diagnosis is M161	13,348	0.567	0.496	0	1
1 if main diagnosis is M162	13,348	0.018	0.134	0	1
1 if main diagnosis is M163	13,348	0.027	0.164	0	1
1 if main diagnosis is M165	13,348	0.014	0.119	0	1
1 if main diagnosis is M166	13,348	0.010	0.099	0	1
1 if main diagnosis is M167	13,348	0.019	0.137	0	1
1 if main diagnosis is M169	13,348	0.030	0.171	0	1
1 if main diagnosis is S720	13,348	0.007	0.085	0	1
1 if main diagnosis is T841	13,348	0.009	0.095	0	1
1 if main diagnosis is T931	13,348	0.025	0.156	0	1
No. secondary diagnoses	13,348	0.865	1.239	0	7
Duration of hip operation (min)	13,229	98	29	19	507
Time and geographical data					
1 if registered on waiting list in 1999	13,348	0.039	0.194	0	1
1 if registered on waiting list in 2000	13,348	0.268	0.443	0	1
1 if registered on waiting list in 2001	13,348	0.273	0.446	0	1
1 if registered on waiting list in 2002	13,348	0.283	0.451	0	1
1 if registered on waiting list in 2003	13,348	0.137	0.344	0	1
Patient's health region (5 dummy variables)	13,348				
Patient's home county (19 dummy variables)	13,348				
1 if treated at private hospital	13,348	0.221	0.415	0	1
1 if treated at university hospital	13,348	0.074	0.262	0	1
Distance to hospital used, travel time by car (h)	13,348	1.126	2.1	0	44.1
Distance to closest hospital, travel time by car (h)	13,348	0.488	0.8	0	7.7
Extra distance to the next closest hospital	13,348	0.857	0.984	0	
Income[c]					
Price-deflated gross income, the year before waiting list registration, NOK	13,348	192261	220741	0	10100000
Average gross income 2000–2003, price deflated, NOK	13,348	193178	217970	0	12000000
Education[c]					
1 if compulsory schooling only	13,348	0.394	0.489	0	1
Marital status, children					

(*Continues*)

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Table AI. *Continued*

	Observed	Mean	SD	Minimum	Maximum
1 if single	13,348	0.070	0.255	0	1
1 if married or registered partner	13,348	0.568	0.495	0	1
1 if widow(er) or if partner is deceased	13,348	0.271	0.445	0	1
1 if divorced or separated	13,348	0.091	0.288	0	1
1 if parent to children <18 years of age, year before wait	13,348	0.147	0.354	0	1

[a]"Multiple PHRs" means primary hip replacement on both hips within the period studied.

[b]Operations caused by "secondary femoral neck fracture" are elective, as they are the result of an unsuccessful hip operation (not hip replacement), which made a primary hip replacement necessary although not as an emergency case.

[c]See also Table I.

CONFLICT OF INTEREST

No potential conflicts of interests exist. This manuscript contains original unpublished work. This article is not being considered for publication at any other outlet, and no duplicate version of this manuscript exists. The research conducted in this study is in compliance with the ethical standards as defined by the authors' institutions.

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