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Backlogs, waiting times and waiting lists of elective surgeries across OECD countries

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Abstract

Background

Many OECD countries suspended elective (non-emergency) care during the pandemic to divert efforts towards COVID-19 patients, which generated a backlog of patients.

Objective

This study measures the extent to which waiting times and volume changed over time before and after COVID-19 in OECD countries (between 2016-2023). We test whether COVID-19 had a different effect on the waiting time of the patients on the list versus the wait of patients treated, two common measures of waiting times. It discusses how waiting times and volume can be used as measures of health system resilience for elective care.

Methods

The study uses data on a selection of high-volume elective surgeries and OECD countries that report waiting times for patient on the list or from addition to the list to treatment. We use regression methods to quantify the extent to which waiting times increased and volumes decreased after the pandemic across OECD countries.

Results

We find that the wait on the list increased on average by 27-30% in the first three years. In contrast, the wait to treatment increased only to a small extent and the effect was not statistically significant. Volume reduced on average by 19% and 10% in the first two years. There were heterogeneous effects across countries, but these do not appear to be systematically related to health spending, physicians and acute beds.

Conclusion

Measures of health system resilience for elective care should monitor both the wait on the list and the wait to treatment, in addition to volumes.

Keywords: waiting times, backlogs, elective surgeries, healthcare systems, resilience.

Research in context

(1) What is already known about the topic?

Long waiting times are a long-standing health policy concern across many OECD countries. Two common measures of waiting times are the waiting time of patients on the list and the waiting time from addition to the list to treatment.

(2) What does this study add to the literature?

The study highlights how disruptions in elective care can have very different effects on the wait of patients on the list versus the wait from addition to the list to treatment. The wait of patients on the list increased rapidly following COVID-19, while the wait to treatment did not. A possible explanation is that the temporary reduction in demand from those who postponed treatment and stayed on the list translated into a shorter waiting time for those who were admitted for treatment. We also document the heterogenous effect of COVID-19 on waiting times and volume across countries.

(3) What are the policy implications?

Monitoring resilience in the context of elective care requires measuring both the waiting time of patients on the list and the wait to treatment, as they provide different signals of the disruptions experienced by the health system. Only monitoring volumes is not sufficient to measure resilience of elective care following disruptions.

Background

COVID-19 has severely disrupted the provision of health care. Many OECD countries suspended elective (non-urgent) care during the pandemic to divert efforts towards COVID-19 patients and avoid others being infected while seeking care. Such disruptions have generated significant backlogs of patients across health systems. Waiting lists and waiting times have rapidly increased as a result (Siciliani et al., 2023a). Long waiting times were a significant health policy concern also before COVID-19 across many countries (Lafortune et al., 2020) where patients had to wait weeks or months to access non-emergency health care.

Health system resilience can be defined as its ability to absorb shocks (OECD, 2023; chapter 1). The ability of the health system to respond can be split into four stages along the disruption cycle: i) plan and prepare before the shock occurs (Prepare); ii) the capability to maintain the core functions and absorb the consequences of the shock (Absorb); iii) the ability to recover the lost functions as quickly as possible (Recover); iv) the capacity to learn and improve capacity based on past experience and prepare for the next cycle (Adapt).

In the context of elective care, the resilience of the health system can be thought of as its ability to minimise disruptions to the supply of elective care, to resume supply and to catch up with the backlog of patients on waiting lists (Siciliani et al., 2023a). COVID-19 introduced a negative shock to the supply of elective care. Following such shock, resilient health systems should be able to quickly bring the supply back to the pre-pandemic levels. The catch-up takes place primarily in the recover stage of the disruption cycle. Ideally, the supply of elective care should temporarily increase relative to pre-pandemic levels to absorb the additional backlog on the waiting list that has cumulated and ensure that waiting times go back to pre-pandemic levels, not only the supply (van Ginneken et al., 2022; Siciliani et al., 2023a).

From a patient's perspective, waiting times are a key indicator of health system responsiveness. Waiting times are a major source of dissatisfaction to patients because health benefits from treatment are postponed. Moreover, patients can experience pain, lack of mobility and discomfort while waiting. The wait can also worsen health outcomes and the ability to benefit from treatment (Moscelli et al., 2016; Moscelli et al., 2015; Gibbs et al., 2024). Waiting times tend to arise in health systems that combine capacity constraints with publicly-funded insurance and limited co-payments (OECD, 2013; Lafortune et al., 2020). If demand exceeds supply, a waiting list is formed, and patients must wait to access health care (Martin and Smith, 1999; Brindley et al., 2023; Siciliani et al., 2023b). Although there is no consensus on what an

"acceptable" waiting time is, many health systems have set maximum waiting-time targets or guarantees of three or six months, and in some cases 12 months (Lafortune et al., 2020; Siciliani et al., 2023b). Shorter maximum wait times can be set when health can deteriorate more quickly while waiting. These differing maximum wait targets across countries reflect the degree of capacity constraints and the mismatch between demand and supply of health care, which varies by institutional setting as a result of funding decisions, differences in capacity, health personnel, acute beds, reimbursement mechanisms, and discharge policies that affect length of stay and use of resources. A recent review by Rathnayake et al. (2025) identifies different policy interventions to reduce waiting times for elective care. It suggests that strategies such as referral management, patient prioritization, and preventing cancellations had the most significant impact on reducing waiting times, while perioperative time management and waiting-time targets proved less effective.

To assess health system resilience in the context of elective care, two common and salient indicators are the volume of elective care and waiting times. The volume allows to measure the extent to which the health system is able to "absorb" the shock and to minimise volume disruptions, and in the "recovery" phase to resume volumes. However, only looking at volumes is not sufficient to monitor patient responsiveness because volumes do not necessarily go hand-to-hand with waiting times. This is because waiting times are a dynamic phenomenon, and they increase over time if the additions to the list are higher than the supply (Gravelle et al., 2003; Brindley et al., 2023). Even if supply increases over time, waiting times can still increase if demand grows at a faster rate than the supply (Siciliani, 2008). Therefore, a second key indicator of resilience in the context of elective care is waiting times.

Waiting times can however be measured in different ways. There are two common measures of waiting times for elective surgery. The first is the wait from addition to the list to treatment, which has the advantage of giving an accurate representation of patient journey but is retrospective in nature. A second measure is the waiting time of patients on the list, which gives a more up-to-date measure of the waiting time but by its nature only captures a segment of the patient journey (Dixon and Siciliani, 2009; Lee et al., 2021). In the context of resilience, both are important. The wait to treatment captures the full patient pathway for those who can access the health system but does not include those whose care has been postponed, which instead is captured by the wait on the list.

This study investigates how waiting times and volume were affected during COVID-19 in OECD countries, and the extent to which they have returned to pre-pandemic levels by 2023. It highlights that waiting time measures matter and that COVID-19 had different effects on the wait on the list as opposed to the wait to treatment. The waiting time of the patients on the list generally increased rapidly, while the waiting time of patients treated only to a much smaller extent. We also document the heterogenous effect of COVID-19 across countries and the extent to which changes in volume and waiting times differ across countries with different levels of health spending, physicians, acute beds, and COVID-19 hospitalisation rates. The study builds on previous work that compares waiting times internationally before COVID-19 (Siciliani et al., 2014; Martin et al., 2020; Lee et al., 2021) and after COVID-19 (van Ginneken et al., 2022; Siciliani et al., 2023a).

Methods

We use data from the OECD Health Statistics database (OECD, 2024). Waiting times are reported for a selection of procedures defined using ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) codes. We focus on six surgical procedures: hip replacement, knee replacement, cataract surgery, prostatectomy, coronary artery bypass grafting and percutaneous transluminal coronary angioplasty. These are high-volume non-emergency procedures across hospital specialties (orthopaedics, ophthalmology, urology, cardiology and cardiothoracic surgery). Waiting times are available only for a very limited number of surgical procedures.

Two measures of waiting times are available: i) the waiting time from specialist assessment to treatment, and ii) the waiting time of the patients on the list. Seven OECD countries report both: Hungary, New Zealand, Portugal, Poland, Spain, Sweden, the United Kingdom. Six countries report only the waiting time to treatment: Australia, Canada, Finland, Italy, Netherlands, Norway. Two countries report only the wait on the list: Ireland and Slovenia. The waiting time from specialist assessment to treatment is a retrospective measure that records the waiting time for all patients who have been treated in a given year. The main advantage is that it captures the patient journey until the patient receives the surgery. However, it is only available with a delay.

The waiting time of patients on the list gives updated information of how long patients have been waiting on the list at a point in time (at a census date). By construction, the waiting time

of the patients on the list is "incomplete", because the patient's wait has yet to come to an end. Intuitively, this should lead to a lower mean waiting time of patients on the list when compared to the wait from assessment to treatment, but this is not necessarily the case. This is because patients with long waits are oversampled compared to patients with short waits (who tend to enter and exit the waiting list more quickly) and this can result into a longer mean waiting time of patients on the list (Dixon and Siciliani, 2009). The waiting time of patients on the list also includes the wait of some patients who eventually drop from the list (for example, if they die while waiting, receive treatment by another provider e.g. in the private sector, or if the patient becomes unfit for surgery; Siciliani et al., 2023a). Both measures of waiting times do not capture the wait from GP referral to treatment, but only after the patient has seen a specialist (what is known as the inpatient waiting time).

We focus on a selection of surgical procedures because these are comparable internationally relative to other types of aggregation (e.g. by specialty). We use the mean waiting time for all countries except for Canada where we use the median waiting time because the mean is not available.

For the same countries that report at least one measure of waiting time, we also use the volume of surgical procedures, which is available from the same source for a larger set of procedures, also defined the same ICD-9-CM codes, and countries. We include the number of procedures per 100,000 persons for all procedures except for prostatectomy where we include the number of procedures per 100,000 men. Our study period includes four years pre-COVID-19 (2016-2019) and four years after COVID-19 (2020-2023). Descriptive statistics are provided in Table A1 in the Online Supplementary Appendix (OSM).

Using the pooled sample across countries, procedures and years, we run several regression models, which we outline more formally in the OSM. In the first model, we regress each of our three outcome variables (wait to treatment, wait on the list, volume) on a set of procedure, country and year fixed effects. The dependent variables are in logs. We use 2019 as our reference year. This allows to test whether waiting times have increased (or volume fallen) following COVID-19, while controlling for systematic (time-invariant) differences across countries and surgical procedures.

In the second regression model, in addition to country, procedure and year fixed effects, we add an interaction variable between the post COVID-19 time dummy and one variable related to health system characteristics (recentred at the sample mean for ease of interpretation): health

expenditure per capita or as percentage of DGP, acute care beds, and physicians (also from the OECD Health Statistics database, 2024). We measure these in 2019, the last year pre-COVID-19, to avoid the "bad control" problem (Angrist and Pischke, 2009) as COVID-19 could itself affect these outcomes. Our hypothesis is that countries with higher capacity are less affected by COVID-19. We also include interactions with the number of COVID-19 hospitalisations (Mathieu et al., 2020) or durations of restrictions to access for non-urgent and elective surgery in 2020 (OECD, 2023), the first year of the pandemic (descriptive statistics in Table A2 in OSM).

In the third regression model, in addition to country and procedure, we interact the post COVID-19 period with each country to obtain an estimate of the change in waiting times or volume for each country in the post COVID-19 period, which we then use to plot against a selection of country-specific variables (e.g. health expenditure). All regression models are estimated with Ordinary Least Squares with robust standard errors.

Results

Table 1 provides the regression result of a specification where we regress our three outcomes (in logs) against country, procedure and year fixed effects. Relative to 2019, the waiting time to treatment increased on average by 5.9%, 8.6%, 14.7% and 12.9% in the four years following COVID-19. However, none of the effects are statistically significant at 5% level. Waiting times to treatment were relatively stable before 2019. The results are markedly different for the wait of the patients on the list. Relative to 2019, the wait on the list increased by 31.0%, 26.8%, 26.9% and 16.1% in each of the four years following COVID-19. All the coefficients are statistically significant at 1% level, except for the last year where it is only at the 10% level. Again, the wait on the list was relatively stable before 2019 though they were somewhat lower in 2016-18. For example, in 2016 the wait on the list was 7.9% lower than in 2019 though the effect is not statistically significant.

Relative to 2019, the volume of surgical procedures reduced by 18.8% in 2020, and 9.6% in 2021, which are both statistically significant at 5% level. Relative to 2019, volume was lower by 0.8% and 9.4% in 2022 and 2023 but the effects are not statistically significant. Volume was relatively stable in the years preceding COVID-19 (and not statistically significant).

There are systematic differences in waiting times across procedures that reflect different levels of urgency. For example, waiting times for hip and knee replacement are on average at least double than the wait to angioplasty. There are also differences across countries. For example, relative to Portugal, waiting times are on average longer in Poland but shorter in Sweden.

[Table 1]

One possible concern with the results in Table 1 is that the sample differs depending on data availability of different measures of waiting times. To check whether the results are sensitive to the availability of different indicators by country, in **Table 2** we restrict the sample and include only the smaller set of seven countries that report both measures of waiting time. The results on waiting times are very similar. Relative to 2019, there are no statistically significant differences in the wait for treatment in the years before or after COVID-19. For the wait on the list, relative to 2019, the wait increased by 31.6%, 25.8%, 27.2% and 16.5% in each of the four years following COVID-19. These are statistically significant at 1% level in the first three years and not significant in the fourth year after COVID-19. The reduction in volume is somewhat larger. Relative to 2019, volume dropped by 26.4% in 2020 and 14.1% in 2021 with both coefficients are statistically significant at 5% level, before resuming to the pre-pandemic levels.

[Table 2]

In **Table 3**, we explore if the changes in waiting times or volume following COVID-19 were heterogeneous across countries with different levels of spending or capacity. Given the relatively small number of countries and possible collinearity between variables (e.g. spending and physicians) we interact each variable with the post COVID-19 dummy one at a time. The results suggest that countries that differed in health spending in 2019 were not affected differently by COVID-19 when looking at the wait on the list or volume regardless of whether we measure health spending per capita or as percentage of GDP or whether we use total health spending or government health spending. For the wait to treatment, we find that countries with higher health spending experienced a larger increase in waiting times (though recall that on average the wait to treatment did not increase).

We find that countries that differed in physicians per 1000 population were not affected differently by COVID-19 when looking at waiting times and volume. This is also the case when interacting the duration of restrictions for non-urgent care and elective surgery. Countries with more acute care beds experienced larger reductions in the wait to treatment. Countries

who had higher hospitalisation rates for COVID-19 cases experienced larger reductions in the wait to treatment while the effect on the wait on the list and volume was not statistically significant. Overall, these findings show that there is no clear pattern between health system characteristics and the effect of COVID-19, though this could also be explained by the limited number of OECD countries included in our analysis.

[Table 3]

To further illustrate the heterogeneity in the change of waiting times and volume experienced across countries following COVID-19, we run one regression model where we interact the post COVID-19 period with each country dummy. The detailed results are presented in the OSM (Table A3). In **Figure 1**, we use the estimated coefficients from Table A3 to plot the increase in waiting times post COVID-19 and the reduction in volume against government health expenditure per capita. Countries that experienced larger increases in the wait to treatment (between 20% and 40% increase evaluated at the sample mean) include Australia, Canada, New Zealand, the Netherlands, Norway and Spain. Countries that experienced larger increases in the wait on the list (between 30% and 60% evaluated at the sample mean) included Hungary, New Zealand and the United Kingdom. Two countries experienced a reduction in volume between 25% and 35% (Hungary and the United Kingdom) while for most of the other countries the reduction in volume was less than 10%. In line with the results in Table 3, there is no association between the change in wait on the list or volume post COVID-19 and health spending, while there is a positive association between the change in wait to treatment post COVID-19 and health spending.

[Figure 1]

Discussion

Our first main finding is that the backlog of surgeries had markedly different effects between the two measures of waiting times. In the first year of the pandemic, the waiting time of patients treated increased only to a small extent, while the wait of patients on the list immediately jumped. One explanation is that some patients initially refused to have surgery for fear of COVID-19 infections while staying in hospitals, while others preferred to receive surgery rather than delay it despite the risk of infections. The reduction in demand from those who

postponed treatment translated into a shorter waiting time for those admitted for surgery. Instead, the wait of the patients who delayed and continued to wait on the list increased rapidly.

As time passed and health services resumed, the patients who received treatment after a long time on the list translated into a longer wait from addition to list to final treatment. Therefore, with a time lag, the wait until treatment also started to increase. The increase of the waiting time of the patients on the list appears however quantitatively more important than the increase in the wait of patients treated also when the supply of surgeries resumed. These findings imply that the waiting time distribution exhibited a higher dispersion with some patients experiencing a similar wait relative to the pre-pandemic levels, while other patients experienced much longer times at least in the short run. We conjecture that patients who were willing to receive surgery were less complex patients and patients with better health. The higher dispersion in waiting times could translate in higher inequalities in experience along the patient journey. As waiting times grow, wait inequalities by socioeconomic status also tend to increase (Landi et al., 2018; Whyte et al., 2020). This suggests that hospitals require more robust processes to manage the waiting list if some patients get ahead of queue.

Volume has on average dropped for two years following COVID-19 before settling again to the pre-pandemic levels. However, resuming activity to pre-pandemic levels is not sufficient to bring waiting times back to the pre-pandemic levels because the supply is offset by new current demand with waiting lists and waiting times stabilising at higher levels (van Ginneken et al., 2022; Siciliani et al., 2023a; Sivey and Wen, 2024). Instead, a surge in volume above the pre-pandemic levels would be necessary to reduce waiting times. Such increase will have to be even higher if demand keeps rising over time due to ageing and technology development. This highlights that to assess health system resilience in the context of elective care, both waiting times and volumes need to be monitored jointly. Our estimates suggest that relative to 2019 volume dropped by 26.4% in 2020 and 14.1% in 2021. This is in line with Siciliani et al. (2023a) who found that across 15 surgical procedures, about 4 million or 18% fewer elective surgical procedures were performed across 31 OECD countries in 2020 compared with 2019.

Moreover, in the context of resilience, the two different measures of waiting times capture different aspects of the recovery. The wait of the patients on the list gives an up-to-date assessment of the status of the patients waiting at any given point in time, which responds more rapidly to possible shocks on elective care. However, the wait on the list does not capture the full patient experience along the patient pathway. This is instead captured by the wait to

treatment though with a delay, as the measure is retrospective. The two measures have also different statistical properties. The distribution of the patients on the list suffers from interruption bias and oversampling of patients with long wait. These biases go in different directions and whether the wait on the list is higher or lower than the wait to treatment is a priori indeterminate (Dixon and Siciliani, 2009). In our data, it is indeed the case that the mean waiting time of the patients on the list is higher for some countries (e.g. Hungary, Poland, Portugal for hip replacement) but not for others (e.g. New Zealand, Spain, the United Kingdom). The mean waiting time of patients on the list appears to be higher than the wait of patients treated in countries with longer waiting times. The wait of patients on the list is likely to be longer in countries which do not check whether patients require treatment on a regular basis, so that some patients will appear having waited for a very long time while not requiring treatment anymore. This further reinforces the need to measure both the wait to treatment and the wait on the list.

Last, we have shown that the increase in waiting times were very heterogeneous across countries. Such heterogeneity does not appear to be systematically related to health spending and other measures of capacity such as acute beds or physicians. This suggests that any country could be adversely affected by supply shocks on elective care, regardless of their institutional arrangements, and that some countries can manage to mitigate such effects. It is however difficult at this stage to pinpoint health system features that are more favourable to health system recovery. A review of policies suggests that a range of initiatives were introduced to reduce waiting times for elective care following the disruptions of the pandemic (Siciliani et al., 2023a). These include additional funding for healthcare providers (e.g. Canada, Ireland, Italy and Finland), extending working hours of health workforce in the evening and weekends (e.g. Italy, Ireland), additional contracting to private providers (e.g. Australia, Canada, Denmark, England, Ireland), dedicated facilities for elective care (e.g. surgical hubs in England), better use of capacity and operating theatres (e.g. extending operating toom hours in Canada), and expansion and retention of health workforce (e.g. Canada, England, Ireland). Maximum waiting time targets or guarantees were temporarily suspended in some countries (e.g. Canada, Finland, Italy, Slovenia) but remain common across OECD countries. Given that waiting times remain long, maintaining maximum waiting times guarantees remains critical to ensure that providers exert effort both to increase or maintain supply while containing demand and avoiding unnecessary referrals (Lafortune et al., 2023).

Conclusion

The COVID-19 pandemic has generated a backlog of elective surgeries that has translated into sustained increases in waiting times across OECD countries. Our analysis highlights that monitoring resilience in the context of elective care requires measuring both the waiting time of patients treated and the wait on the list. The two wait measures provide different signals of the disruptions experienced by the health system. Only monitoring volumes is also not sufficient to measure resilience of elective care following a shock. Even if volume increases over time, this is no guarantee that the waiting list and waiting time will go down if demand grows at a faster rate than supply. Resilient health systems instead require surge capacity if they want to bring waiting times back to levels preceding the shock.

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Table 1. Regression results

Variables	(1) Log of waiting time to treatment	(2) Log of waiting time on the list	(3) Procedure per 100,000 persons
2016	0.0373	-0.0790	-0.0304
	(0.0918)	(0.0873)	(0.0403)
2017	-0.0183	-0.0878	-0.0126
	(0.109)	(0.0819)	(0.0398)
2018	0.0639	-0.0779	-0.00825
	(0.0851)	(0.0840)	(0.0403)
2019	Ref	Ref	Ref
2020	0.0586	0.310***	-0.188***
	(0.0983)	(0.0755)	(0.0435)
2021	0.0860	0.268***	-0.0957**
	(0.0949)	(0.0905)	(0.0466)
2022	0.147	0.269***	-0.00838
	(0.0995)	(0.0907)	(0.0448)
2023	0.129	0.161*	-0.0937
	(0.113)	(0.0943)	(0.112)
Angioplasty	Ref	Ref	Ref
Coronary bypass	0.613***	0.680***	-1.824***
	(0.154)	(0.107)	(0.0368)
Prostatectomy	0.928***	0.299***	-0.648***
	(0.172)	(0.112)	(0.0399)
Hip replacement	1.805***	1.205***	-0.0178
	(0.145)	(0.0988)	(0.0346)
Knee replacement	2.033***	1.331***	-0.407***
	(0.148)	(0.100)	(0.0367)
Cataract	1.494***	0.632***	1.514***
	(0.147)	(0.0969)	(0.0422)
Portugal	Ref	Ref	Ref
Australia	0.113		0.920***
	(0.106)		(0.0690)
Canada	-0.593***		0.686***
	(0.157)		(0.0747)
Finland	-0.156		0.820***
	(0.115)		(0.0554)
Hungary	-0.589***	-0.415***	0.232***
	(0.160)	(0.100)	(0.0667)
Italy	-0.457***		0.587***
	(0.111)		(0.0442)
Netherlands	-0.370***		0.728***
	(0.136)		(0.0453)
New Zealand	0.0995	-0.708***	0.186**
	(0.119)	(0.0696)	(0.0732)
Norway	0.462***		0.379***
	(0.122)		(0.0738)
Poland	0.512***	0.947***	0.0687
	(0.160)	(0.125)	(0.0571)
Spain	-0.0816	-0.676***	0.246***
	(0.168)	(0.0623)	(0.0595)
Sweden	-0.317***	-0.706***	0.545***
	(0.102)	(0.0994)	(0.0511)
United Kingdom	0.0251	-0.394***	0.234***
	(0.147)	(0.0600)	(0.0553)
Ireland		0.223***	
		(0.0836)	
Slovenia		0.597***	0.575***
		(0.0768)	(0.0417)

Constant	3.071***	4.128***	4.797***
	(0.204)	(0.119)	(0.0510)
Observations	502	367	521
R-squared	0.644	0.751	0.944

Notes. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 The model regresses the log of waiting time or volume on a set of year, procedure and country dummies.

Table 2. Regression results with restricted sample

Variables	(1) Log of waiting time to treatment	(2) Log of waiting time on the list	(3) Procedure per 100,000 persons
2016	0.161	-0.133	-0.0226
	(0.139)	(0.104)	(0.0572)
2017	-0.0300	-0.129	-0.00297
	(0.171)	(0.0971)	(0.0553)
2018	0.121	-0.0850	-0.00485
	(0.127)	(0.103)	(0.0554)
2019	Ref	Ref	Ref
2020	0.0236	0.316***	-0.264***
	(0.147)	(0.0886)	(0.0602)
2021	0.0665	0.258**	-0.141**
	(0.144)	(0.102)	(0.0714)
2022	0.0421	0.272***	-0.00575
	(0.146)	(0.100)	(0.0577)
2023	0.0683	0.165	-0.0996
	(0.142)	(0.111)	(0.120)
Angioplasty	Ref	Ref	Ref
Coronary bypass	1.268***	0.815***	-1.853***
	(0.254)	(0.131)	(0.0597)
Prostatectomy	1.175***	0.529***	-0.757***
	(0.273)	(0.139)	(0.0568)
Hip replacement	2.252***	1.466***	0.0341
	(0.238)	(0.119)	(0.0497)
Knee replacement	2.555***	1.588***	-0.427***
	(0.242)	(0.120)	(0.0590)
Cataract	1.825***	0.829***	1.668***
	(0.243)	(0.120)	(0.0592)
Portugal	Ref	Ref	Ref
Hungary	-0.570***	-0.394***	0.233***
	(0.141)	(0.103)	(0.0598)
New Zealand	0.138	-0.686***	0.177**
	(0.123)	(0.0754)	(0.0793)
Poland	0.592***	0.970***	0.0311
	(0.150)	(0.114)	(0.0524)
Spain	-0.0785	-0.690***	0.247***
	(0.152)	(0.0622)	(0.0560)
Sweden	-0.319***	-0.726***	0.545***
	(0.0997)	(0.0982)	(0.0394)
United Kingdom	0.0153	-0.369***	0.235***
	(0.158)	(0.0709)	(0.0473)
Constant	2.671***	3.938***	4.802***
	(0.278)	(0.148)	(0.0596)
Observations	268	278	266
R-squared	0.657	0.767	0.945

Notes. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 The model regresses the log of waiting time or volume on a set of year, procedure and country dummies. The sample is restricted to countries that report both measures of waiting times (the wait from patient addition to list to treatment and the wait on the list).

Table 3. Interactions between COVID-19 dummy and health system variables

Variables	(1) Log of waiting time to treatment	(2) Log of waiting time on the list	(3) Procedure per 100,000 persons
Health exp per capita*covid-19	0.000140***	-2.96e-05	2.58e-05
	(4.59e-05)	(5.55e-05)	(2.41e-05)
Health exp as % of GDP*covid-19	0.116***	0.0163	0.0266
	(0.0434)	(0.0351)	(0.0203)
Govt. health exp. per capita*covid-19	0.000145***	-2.19e-05	1.86e-05
	(4.74e-05)	(5.73e-05)	(2.52e-05)
Acute beds*covid-19 dummy	-0.284***	0.0590	-0.0709
	(0.100)	(0.0933)	(0.0447)
Physician*covid-19 dummy	0.134	-0.0858	0.0714
	(0.120)	(0.0852)	(0.0513)
Covid cases*covid-19 dummy	-7.06e-06***	2.83e-06	-1.29e-06
	(2.03e-06)	(4.19e-06)	(1.18e-06)
Duration of restriction*covid-19 dummy	0.00846*	-0.00134	0.000338
	(0.00441)	(0.00616)	(0.00217)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. For each variable, a regression model includes the interaction between the variable of interest the post COVID-19 dummy, in addition to year, country, and procedure fixed effects reported in Table 1. See Online Supplementary Material for details of the econometric specification.

Figure 1.a. Waiting time to treatment and government health expenditure per capita (US dollar: PPP converted)

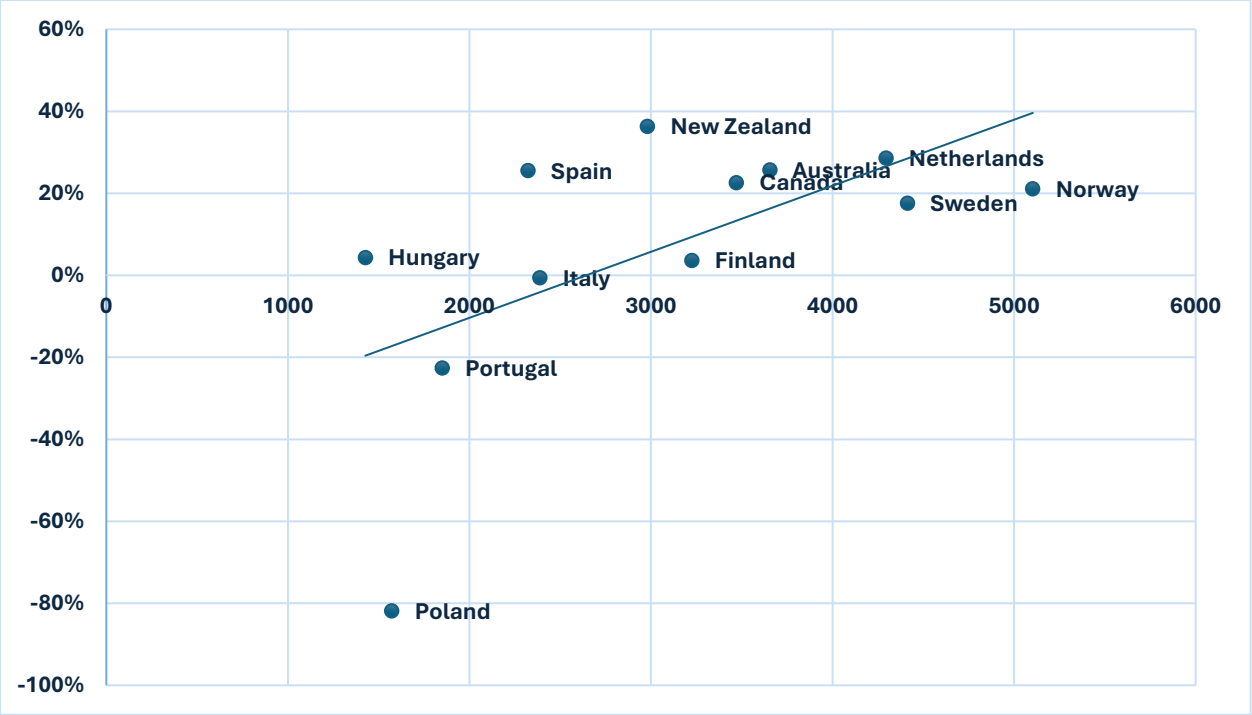

Figure 1.b. Waiting time on the list and government health expenditure per capita (US dollar: PPP converted)

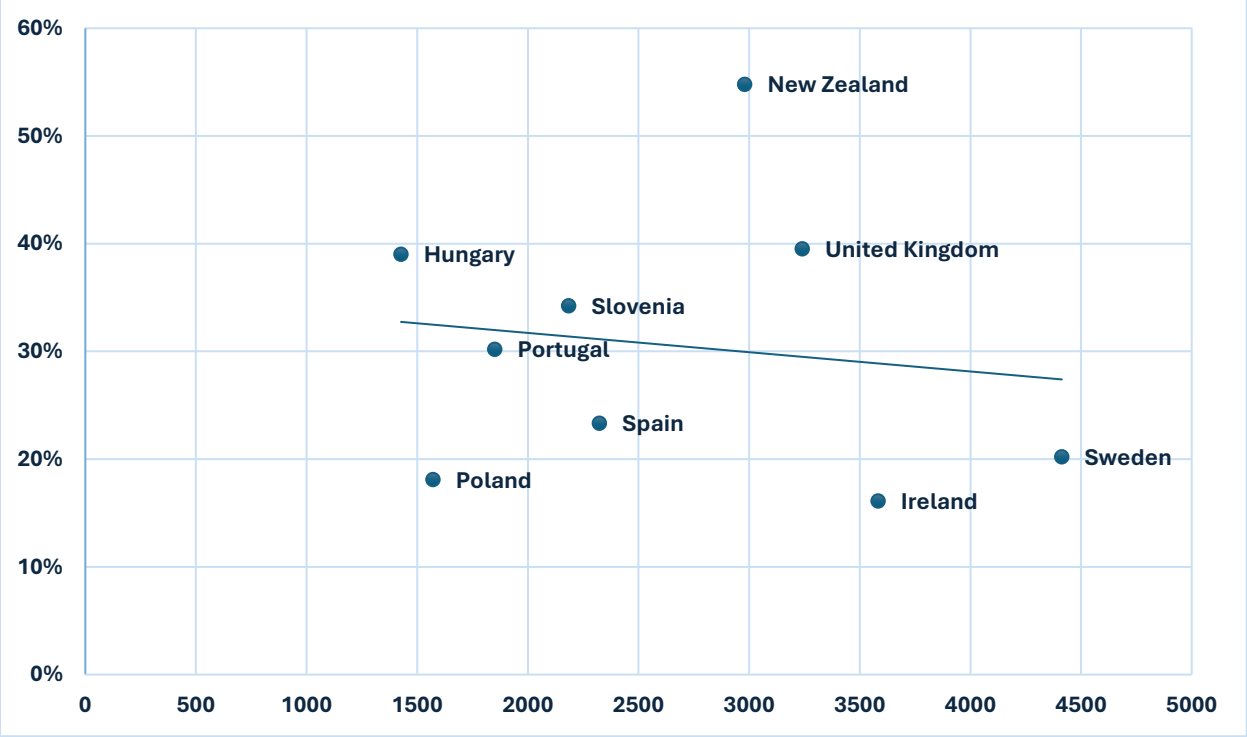

Figure 1.c. Volume and government health expenditure per capita (US dollar: PPP converted)