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The effect of community diagnostic centres on volume and waiting time for diagnostic procedures in the UK

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ABSTRACT

Many health care systems are looking to implement policies to improve productivity and accessibility of health care. In this paper we use data from the English National Health Service to evaluate the effect of introducing new "Community Diagnostic Centres" in 2021 which aim to increase volume, reduce waiting times, and increase accessibility to diagnostic procedures. Our results show an increase in volume of diagnostic procedures associated with the introduction of CDCs at local NHS organisations. We find some evidence the increase is driven by an increase in MRI scans in particular, and this result is larger for CDCs located in more deprived local areas. We find no effect on waiting times which may indicate some demand response to increased availability of tests.

1. Introduction

A persistent concern in publicly-funded health systems is waiting times and timely access to elective care. In particular, in countries such as the UK, the COVID-19 pandemic has lead to increased waiting times for elective procedures such as hip replacements and cataract surgeries [1]. Another bottleneck in the system has been in provision for diagnostic procedures such as MRI and CT scans, endoscopies and ultrasounds with the number of patients waiting more than 6 weeks for a diagnostic test jumping from about 3% prior to the pandemic to 26% in May 2022 [2]. One concern with the provision of elective diagnostic care, where patients have to wait for non-urgent tests, is that the facilities and staff providing tests can be interrupted by the needs of emergency care, especially when staff are fungible between emergency and elective settings.

Even prior to the pandemic, the number of patients on the waiting list for diagnostic tests had been gradually increasing from 2008 until 2019, with median waiting times reaching two weeks prior to the pandemic [3]. One explanation for lengthening waiting lists pre-pandemic could be a lack of capital resources for diagnostic procedures, Richards [4] quotes OECD data from 2017 showing that England has a very low density of capital stock in terms of MRI and CT scanners per 10,000 population, with England placing 34th of 38 OECD countries with less than half of the density of France and Spain and less than a quarter of the density of the USA or Australia.

A recent policy response in the UK is the introduction of new "community diagnostics centres" (CDCs) from July 2021 [4–6]. These facilities serve several purposes. Firstly they add capacity in diagnostic care, including the provision of both more machines and staff. Secondly they separate planned diagnostic facilities from emergency care, ring-fencing staff and capital. Thirdly, deprived populations in England are more likely to be diagnosed with cancer at a later stage [7] and so the selection of CDC locations aims to narrow these health inequalities by providing better access to diagnostics in more deprived areas [4].[2] .

The introduction of CDCs was planned to require an additional 2000 radiologists and 4000 radiographers as well as other support staff [4]. The number of radiologists working in the NHS has grown faster than most other medical specialities in recent years, increasing by 65%

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[2] Another purpose of CDCs is to minimise risks of transmission of Covid-19 between patients, visitors and staff during the diagnostic process. For example, CDCs are supposed to be established away from acute hospital sites, and investigations for patients who have active Covid-19, or those who require urgent diagnostics, are not supposed to be undertaken in these centres [4].

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between 2010 and 2023 compared to an increase 38% in qualified technical staff such as Radiographers and 25% in all hospital doctors [8]. However there are still claims of persistent staff shortages amongst both Radiographers and Radiologists which may affect the effectiveness of the implementation of CDCs [6,9,10].

In this paper, we aim to evaluate the effects of the CDC programme on its stated objectives, including increasing the volume of diagnostic procedures and reducing waiting times.

There is little research directly evaluating initiatives such as the CDC programme. Wale et al. [11] provide a systematic review of studies across Canada, the UK and Spain on diagnostic centres and find mixed results on a variety of outcome measures including waiting time to diagnosis and from diagnosis to treatment. Many studies focus on cancer patients and the speed of diagnosis, for example Jiang et al. [12] provides evidence from specialised breast cancer units in Canada and Friedemann Smith et al. [13] provides a systematic review of similar interventions in the UK, Australia and Singapore. Other studies focus on direct referrals from primary care and avoiding hospital emergency department visits [14,15]. A recent review article [16] includes literature from the UK, Netherlands, Denmark and Ireland and argues that direct referrals to imaging from primary care providers has many potential benefits for patients but more research is needed.

The launch of the community diagnostic centres (CDCs) policy in 2021 initially consisted of 40 new CDC facilities [6] which has grown to more than 100 by mid-2023 and aims to reach 160 by 2025 [17]. The government invited bids from NHS organisations across the country and decided where to locate them according to several factors including tackling inequalities and reducing waiting times [5]. The introduction of CDCs came after the peak phases of the COVID-19 pandemic in England which saw a series of national lockdowns and brief periods of regional restrictions throughout 2020 and early 2021 [18,19]. As of June 2023, CDCs had carried out more than 4 million tests, checks and scans, with the aim of increasing diagnostic activity by 9 million tests per year by 2025 [20], which would be an increase of approximately 37% from 2022 levels. The CDCs are funded by £2.3 billion in new funding.

Our study adds to the literature by being the first evaluation of a major national programme, using robust evaluation methods and considering waiting time before the procedure and volume as outcome measures.

2. Materials and methods

2.1. Data

CDCs have been introduced in a staggered fashion, starting from July 2021 [5]. In this study, we use administrative data from the Diagnostic Waiting Times and Activity dataset for the period between April 2018 and January 2023. It contains monthly diagnostic activities at the provider-level published by the NHS in England. The data set includes NHS Trusts and Independent Sector (private) organisations providing NHS services. As the creation of CDCs is an organisational innovation within NHS organisations across England [21], independent sector providers are excluded in the analysis.

NHS trusts are public sector bodies "to provide healthcare services to the NHS" [22]. They have "a board of executive and non-executive directors, and are accountable to the secretary of state" [23]. In total there are 182 NHS trusts [22] in our analysis. For each trust-month observation, we calculate the number of non-emergency (planned and waiting list) diagnostic procedures carried out in the trust over the month. In addition, the data collection includes information on the number of patients on the waiting list for tests and patients waiting 6 and 13 weeks. We compute the percentage of waiting 6 weeks or above as a measure of the waiting time.

We use variation in the timing the opening of CDCs across trusts from the government's report [5]. It includes information about the geography, names and opening time of operational CDCs. The post-CDC dummy variable is created based on the opening time. To match CDCs with their parent trusts and corresponding codes, we use the ODS Portal developed by NHS Digital. There are 64 CDCs matched with the corresponding NHS trusts. The timing of the opening of these CDCs varies between July 2021 and June 2022.

To investigate whether the implementation of CDCs can reduce inequality in diagnostic services, we also obtain data on household income for all middle layer super output areas (MSOA) from the Office for National Statistics [24], and match CDCs with MSOAs. It is completed in two steps. First, we collect information on postcodes for each CDC from ODS Portal. Second, using information on their postcodes, we identify the corresponding MSOA for each CDC on Open Data Camden [25]. In doing so, we are able to learn whether a CDC provides diagnostic services in a relatively more or less deprived community.

2.2. Baseline model

We estimate the effect of introducing the CDCs on diagnostic services by comparing changes in diagnostic test volume and share of tests waiting over 6 weeks for NHS trusts with and without CDCs before and after the opening of the CDCs. We base our estimates on a two-way fixed effects (TWFE) model. Trusts opening the CDCs are expressed by a dummy variable, which equals one if a trust opens the CDC or not. Two outcomes are measured: i) the planned and waiting list diagnostic test volume (measured in the number of performed tests, ii) waiting time (measured in the share of patients waiting over 6 weeks for a test). The difference in test volumes and waiting times across NHS trusts could be attributed to variation in many other fixed characteristics rather than variation in CDCs. In our regression model, we include trust fixed effects which take into account all time-invariant factors at the trust level such as the size of hospital, staffing, location, speciality and history. In doing so, we are able to isolate the impact of CDCs from the impact of trusts' characteristics. Time fixed effects account flexibly for common shocks across trusts, and we also include trust-specific time trends, to account for trust-specific factors varying over time before the introduction of CDCs, including factors related to the impact of COVID-19 across different local areas. All standard errors are clustered at the trust level to allow for correlation of errors over time within trusts. Our estimate of interest identifies the impact of the CDCs comes from within-trust variation after netting out variation in the outcome variable caused by factors that vary linearly over time and that are specific to individual trusts. We also conduct separate regressions for Magnetic Resonance Imaging (MRI) scanner tests, Computed Tomography (CT) scanner tests and other tests. As a robustness check, we also follow the same specification but use a different data source, HES outpatient data, to examine the impact of introducing CDCs.

In order to study whether the introduction of CDCs reduces health inequalities and variation in access to diagnostic services, we proceed in three steps: first, we divide the CDCs into two groups by the household income of their corresponding MSOAs; second, we exclude 32 trusts with CDCs of below household income and run the same regression; third, we exclude 32 trusts with CDCs of above household income and conduct the same regression analysis.

2.3. Event study models

The results from the baseline models could be biased if CDCs are rolled out disproportionately in trusts that would have experienced a change in the number of diagnostic tests even absent the introduction of CDCs. That would be the case if, for example, trusts providing a large number of diagnostic tests have some influence on the location of new CDCs. Although we cannot rule out this possibility, we can check for differential trends in the test volume between CDC and non-CDC trusts in the months leading up to the establishment of a CDC.

A growing branch of econometrics literature has documented problems related to TWFE models arising from staggered treatment timing

Table 1
The impact of opening CDCs on tests volume and waiting time.

	Total Planned Tests Volume			Share of Waiting 6+ Weeks		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-CDC	1802.313***	1176.423***	634.852**	11.517***	4.241**	2.980
	(421.363)	(431.318)	(294.428)	(1.377)	(1.766)	(1.871)
Trust Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	NO	YES	YES	NO	YES	YES
Trust Specific Time Trends	NO	NO	YES	NO	NO	YES
Observation	9467	9467	9467	9365	9365	9365

Note: This table presents the effect of opening CDCs. The outcome variable is the number of planned and waiting list tests at the provider-month level in Columns 1 to 3, while the outcome variable is the percentage of waiting time above 6 weeks (%) in Columns 4 to 6.

[26,27]. In particular, the TWFE estimator "equals a weighted average of all possible simple 2 × 2 DDs that compare one group that changes treatment status to another group that does not, which could lead to negative weights for treatment effects and produce biased estimates" [27].

In order to allow for heterogeneity in treatment effects across time and treated units and test for parallel trends, we also estimate the dynamics of treatment effects using a recently proposed estimator by Sun and Abraham [27] that is robust to treatment effect heterogeneity. Specifically, their estimator categorises units into different cohorts e based on their initial treatment timing, to avoid the estimates of lags and leads being contaminated by effects from other periods. Where time windows span periods of one month each. Each lag(lead) takes the value of the main regressor -*k(k)* months away from the CDC opening. CDC_{pt}^{k} is a set of relative event-time dummies, that take value of 1 if time t is k months after (or before, if k is negative) the opening. e stands for cohorts, different time periods in which units are treated. They define their estimates as "interaction-weighted" estimates generated in two steps: first, the cohort average treatment effects on the treated (CATT) are computed by estimating "the cohort-specific average difference in outcomes relative to never being treated" [27]; second, their estimator estimates "a weighted average of CATT with weights equal to the share of each cohort in the relevant period(s)" [27].

Each estimated coefficient is a weighted average of the effect of an opening of a CDC a certain number of months before or after opening. For instance, the coefficient for the event time of +8 represents the effect of a CDC on the outcome 8 months after the opening. We also present the event study figure generated by the alternative estimator recently developed by Callaway and Sant'Anna [26] to show the robustness of results. The results are shown in Appendix Figure 3.

3. Results

3.1. Descriptive statistics

Appendix Figure 1 presents the time trends in the total number of planned diagnostic tests over time from 2018 to 2022, using the NHS monthly data. As shown in the figure, there is a collapse in the diagnostic volume at the beginning of the Covid-19 pandemic in April 2020, while it recovers soon after April 2020 to near pre-pandemic levels and remains stable at the volume of 1.5 million per month.

Appendix Table 1 displays the summary statistics of planned diagnostic tests over the study period. We match CDCs with their corresponding trusts. Panel A shows that the average monthly number of planned tests for the whole time period performed for trusts with and without CDCs which open during the period are approximately 10,395 and 6971, respectively. It suggests that CDCs are opened in trusts with a relatively large test volume. Panel B shows that average test volume before and after CDCs are introduced in trusts where they are opened increases from 9855 to 11,867.

3.2. Baseline results for volume

Columns 1 to 3 of Table 1 present the estimates of β_1 in the TWFE model. The first column in the table displays results for the base specification, which includes only trust fixed effects. In the second column, we also include time fixed effects. In the third column, we further add trust-specific time trends to account for the possibility that trusts might be on different linear trends in diagnostic test volume. Our results are fairly stable across specifications. The point estimates decrease but remain significant at the 5 percent level when trust-specific time trends are included.

The effect size on the diagnostic test volume in the base specification, namely the one that includes only trust fixed effects is 1802, which is equivalent to around 17 percent of the mean value. The coefficient reduces to 635 in our preferred specification that includes trust specific time trends. This suggests that the CDC introduction leads to an increase of 6% in the number of planned diagnostic tests. The decrease in the magnitude of the effect once time trends are controlled for suggests that there could be a large part of differences in test volume between CDC and non-CDC trusts attributed to differences in capacity and trends across hospitals.

Appendix Table 2 shows that the introduction of CDCs is associated with an increase in MRI scanner tests of around 165 tests, about 26% of the total increase.[3] For CT scanner tests, the point estimates are positive, though not significant at conventional levels after taking account of trust specific time trends in Appendix Table 3. We also repeat the same exercise for other test types such as non-obstetric ultrasound, audiology assessments, and cardiology. Appendix Table 4 shows that CDCs bring about an increase of approximately 376 tests in these other test types, about 59% of the total increase.

3.3. Robustness checks

Appendix Tables 5 to 8 estimate the same specification but use the HES outpatient data. In the preferred specification, they show no effect of CDC opening on volume but this is likely due to the outpatient data under-recording CDC activity.

3.4. Baseline results for waiting time

Columns 4 to 6 of Table 1 presents the estimated impact of the CDCs introduction on the share of patients waiting over 6 weeks for a planned diagnostic test (%). As before, we check the sensitivity of the results to the inclusion of trust fixed effects and trust-specific time trends controls. The estimate in column 4 suggests that the introduction of CDCs is statistically significantly associated with a 12% increase in the share of patients waiting over 6 weeks for a test after including trust fixed effects.

[3] MRI scans are more time-consuming and resource-intensive than x-rays or CT scans but provide better soft tissue contrast and can differentiate better between fat, water, muscle, and other soft tissue [30].

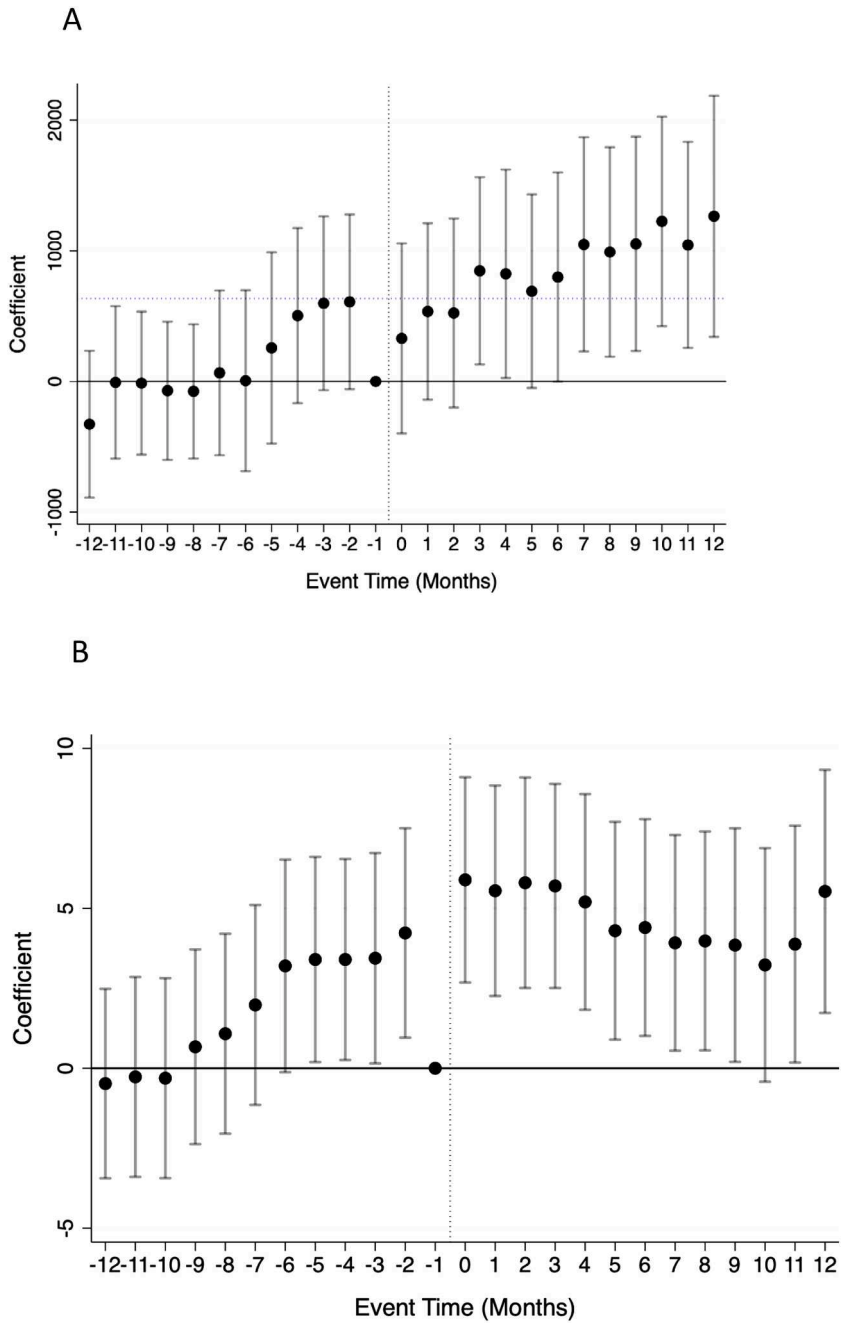

Fig. 1. A: The effect of CDCs on planned test volume

Notes: The figure presents the event-study plots of the effect of CDC openings on total planned diagnostic test volume, following Sun and Abraham [27]. Standard errors are clustered at the trust level. Bands indicate 90% confidence intervals.

B The effect of CDCs on Share of 6+ Weeks Waiting

Notes: The figure presents the event-study plots of the effect of CDC openings on share of tests waiting over 6 weeks, following Sun and Abraham [27]. Standard errors are clustered at the trust level. Bands indicate 90% confidence intervals.

In column 5, we further include time fixed effects and find a drop in its magnitude from 12% to 4%. This suggests that much variation in the waiting time could be driven by the time shocks. For instance, the Covid-19 pandemic could interrupt the diagnostic services in all trusts and therefore explain variation in waiting time. When we take account of the time trends in column 6, we no longer detect a statistically significant association between CDCs and waiting time. This result reveals that trust specific time trends could bias our estimates in the first two columns. For instance, possible differences in trends before the introduction of CDCs could lead to post-treatment differences in trends.

We also examine the association between the introduction of CDCs and the number of patients on the waiting list. Appendix Table 9 shows the corresponding results. Again, we find a consistent pattern across specifications. There is a significant positive association in Columns 1 and 2, yet the significance disappears after we take account of trust specific time trends. In addition, we look into the number of procedures on the waiting list for over 6 and 13 weeks, respectively and find similar results in Appendix Tables 10 and 11.

Appendix Table 12 presents the regression results of the waiting time for the sample of excluding trusts without CDCs. Similarly, we do not find that waiting times fall after opening CDCs. This suggests that there could be selection effects with respect to waiting time around the

Table 2
The impact of opening CDCs on total planned tests volume.

	Excl. High-Income CDCs			Excl. Low-Income CDCs		
	(1)	(2)	(3)	(1)	(2)	(3)
Post-CDC	1899.828***	1306.403**	985.164**	1703.287***	1109.880*	467.327
	(597.273)	(596.117)	(403.424)	(575.846)	(598.146)	(418.894)
Trust Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	NO	YES	YES	NO	YES	YES
Trust Specific Time Trends	NO	NO	YES	NO	NO	YES
Observation	7686	7686	7686	7735	7735	7735

Note: This table presents the effect of opening CDCs on the number of planned and waiting list tests at the provider-month level. The analysis excludes the sample of CDC-trusts in middle layer super output areas with above median income in Columns 1 to 3, while the analysis excludes the sample of CDC-trust in middle layer super output areas with below median income in Columns 4 to 6.

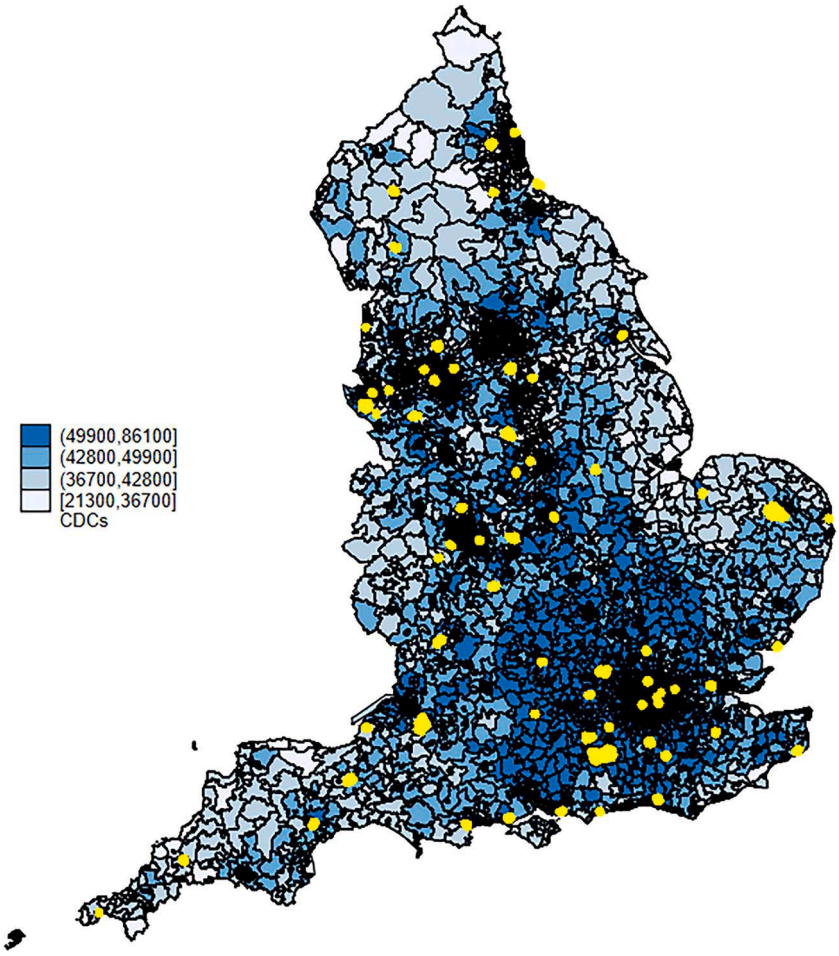

Fig. 2. Annual income-MSOAs.

opening timing of CDCs.

3.5. Event study results

Fig. 1A displays the corresponding results for diagnostic test volume by using the estimator developed by Sun and Abraham (2020). It shows that the estimates are consistent with the parallel trends assumption: the coefficients on the months prior to the introduction of a CDC are not statistically significantly different from zero. While the coefficients in the few months just prior to CDC opening are positive (but not statistically significant), this may indicate some build-up of capacity in a trust just prior to the CDC opening. Fig. 1 also documents the dynamics of treatment effects: the effects occur 6 months after the opening and are persistent. The delayed effect of CDCs on test volume could be explained by the differences between the official opening date and the date when the facilities are fully functional. Appendix Figure 3 also presents the dynamic results from the alternative estimator, and we find consistent patterns using other estimators.

Fig. 1B shows the effects of CDCs on the share of patients who wait over 6 weeks for a diagnostic test. However, unlike the test volume outcome we have examined, there is evidence of differential pretrends in waiting time for a test. Waiting time appears to be longer preceding the introduction of CDCs in CDC trusts than in non-CDC trusts. The existence of these pretrends makes us reluctant to interpret the estimated increase in the share of over 6 weeks waiting during the posttreatment periods causally. It is worth noting that these pretrends may justify the positive and significant estimates from the TWFE model in Table 2, as higher waiting times in diagnostic procedures may induce trusts to open CDCs.

3.6. Inequality analysis

Fig. 2 displays the geographic distribution of CDCs we use in the analysis with their corresponding MSOAs. CDC-MSOAs are denoted by yellow points. Overall, it appears that CDCs are fairly evenly spread across England. The figure also shows annual household income at the MSOA level. To complement the figure, Appendix Table 13 further presents the average household income for all MSOAs and CDC-MSOAs, respectively. We find that the mean household income of all MSOAs is higher than that of CDC-MSOAs, which reflects that CDCs are more likely to be opened in relatively income-deprived areas.

Table 2 look into the heterogeneity by income deprivation of CDC-MSOAs. Columns 1 to 3 reports the estimates from the specifications where CDCs with relatively high household income are excluded. We find strong positive effects throughout the specifications. The preferred estimate in column 3 suggests that CDCs lead to an increase by around 985 tests per month. However, when we exclude low-income CDCs in the analysis, the point estimate loses its significance, as shown in column 6 of Table 2. The striking difference in estimated effects between the two exercises allow us to interpret these results as suggestive evidence that the detected effect of CDCs on diagnostic test volume is mainly driven by CDCs located in relatively income-deprived areas.

4. Discussion

The CDCs programme is a policy initiative from the UK government aiming to deliver additional diagnostic capacity, improve patient experience, and reduce health inequalities by "ring fencing" of staff and imaging equipment for elective diagnostic services [4]. This initiative mirrors related policies across the world to allow direct access from GPs to diagnostic services [16], or to expand access to diagnostics through specialised centres (Friedemann [13,11]).

Using NHS diagnostic data from England and a difference-in-difference analytical design we detect that the CDCs programme increases the number of planned diagnostic tests performed in areas where they were introduced.

Specifically, the difference in trend in diagnostic test volume between trusts with and without CDCs is statistically insignificant prior to the opening. Six months after opening a CDC, trusts experienced a persistent increase in test volume of approximately six to 10 percent, and in the following six months by between six to 13 percent. We present suggestive evidence showing that the effect is mainly driven by trusts with CDCs in relatively income-deprived areas, and a substantial proportion of the increase in tests are made up of MRI scans. We are uncertain if the detected increase in tests is due to greater capacity in the provision of tests, an increase in efficiency, or both, this remains a limitation of our study.

A simple calculation from our analysis suggests that the CDC policy could lead to an increase in test volume of around 2.5 million (635 per month per trust x 64 CDC trusts x 12 months x 5 years =2438,400) over five years. This would fall short of the government's target of 9 million additional tests by 2025, but it is a lower bound estimate, as it is based on the assumption that no further CDCs are introduced and existing CDCs are not expanded.

As the supply of diagnostic tests increases in a given area, we may expect waiting times to fall, if demand remains constant. However, our results show little evidence of the CDC programme leading to a fall in patients' waiting time for a diagnostic test. CDCs appear to have been opened in trusts with higher waiting times, but we don't find evidence of a fall in waiting times subsequent to the opening of the CDC. As we show that the opening of CDCs is associated with an increase in tests but no reduction in waiting time, this may suggest that the opening of a CDC led to an increase in demand (from patients and GPs) for diagnostic tests in an area, therefore mitigating any downwards effect on waiting times [28]. It is also possible that the effect of CDCs on waiting time is gradual rather than immediate and our dataset is too short to detect such an effect, this remains a limitation of our study.

5. Conclusions

The recent NHS Elective Recovery Plan [29] announced the provision of dozens more community diagnostic centres, but the impact of these new facilities are still not well understood. Our research sheds light on the impact of this initiative for those trusts which have opened CDCs since the announcement of the policy. Our results show an increase in volume of diagnostic procedures associated with the introduction of CDCs at local NHS organisations, particularly, and this result is larger for CDCs located in more deprived local areas. We also find no effects of the introduction of CDCs on waiting times for diagnostic tests. Our results may be influenced by contextual factors around the NHS in the early 2020s, for example the pent-up demand for health care following the COVID-19 pandemic

This suggests that those seeking to introduce more CDCs should take account of the socio-economic characteristics of potential patients and access inequality. The NHS has started to publish data on activity in CDCs as a subset of the Monthly Diagnostics Data from March 2023, and it remains to be seen if further beneficial impacts will be identified using CDC-specific data.

CRediT authorship contribution statement

Peter Sivey: Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis. **Jinglin Wen:** Writing – original draft, Software, Investigation, Formal analysis, Data curation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2024.105101.

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