NBER WORKING PAPER SERIES

THE HEALTH AND EMPLOYMENT EFFECTS OF EMPLOYER VACCINATION MANDATES

Ashvin Gandhi
Ian Larkin
Brian McGarry
Katherine Wen
Huizi Yu
Sarah Berry
Vincent Mor
Maggie Syme
Elizabeth White

Working Paper 33072
http://www.nber.org/papers/w33072

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 2024

The primary research team included (alphabetical): Ashvin Gandhi, Ian Larkin, Brian McGarry, Katherine Wen, and Huizi Yu. Authors may list ordering however they deem appropriate. Under clinical journal conventions, Katherine Wen would be first author and Ashvin Gandhi would be last author. We thank Marion Aouad, David Gifford, David Grabowski, and Cyrus Kosar for helpful comments, as well as seminar and conference participants at Vanderbilt University, the National Bureau of Economics Research Summer Institute, the Midwest Healthcare Conference, and the American Society of Health Economics Annual Conference. This work was supported by a grant from the National Institute on Aging (U54AG063546). The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

The Health and Employment Effects of Employer Vaccination Mandates
Ashvin Gandhi, Ian Larkin, Brian McGarry, Katherine Wen, Huizi Yu, Sarah Berry, Vincent Mor, Maggie Syme, and Elizabeth White
NBER Working Paper No. 33072
October 2024
JEL No. I1, I10, I12, I18, J2, J28, J30

ABSTRACT

Health care facilities considering mandating staff vaccination face a difficult tradeoff. While additional vaccination coverage will directly reduce disease transmission within the facility, the imposition of a mandate may also cause vaccine-hesitant staff to quit, which could harm patient care. To study this tradeoff, we leverage comprehensive administrative data covering virtually all US nursing homes, including payroll-based records on approximately 500 million daily nurse shifts and weekly data on COVID transmission and mortality at each facility. We use a difference-in-differences framework to estimate the impact of employer-imposed vaccine mandates at 581 nursing homes on disease spread, employment outcomes, and several patient care metrics. While mandates did slightly increase staff turnover, the effects were concentrated on staff working less than 20 hours per week, and resulted in a reduction of less than two minutes per patient-day. Furthermore, there is only limited evidence of lower levels of care at mandate facilities in typically-monitored conditions such as patient falls, pressure ulcers, or urinary tract infections. In contrast, implementing a vaccine mandate led to large increases in staff vaccinations at mandate facilities, which directly led to less transmission of and lower patient mortality from COVID. We estimate that vaccine mandates saved one patient life for every two facilities that enacted a mandate, a large effect given the typical facility has around 100 beds. Our results suggest that the health benefits of mandates far outweigh the costs in terms of reduced patient care from staff turnover.

Ashvin Gandhi
University of California at Los Angeles
Anderson School of Management
110 Westwood Plaza
Los Angeles, CA 90095
and NBER
ashvin.gandhi@anderson.ucla.edu

Ian Larkin
Harvard University
ian.larkin@anderson.ucla.edu

Brian McGarry
University of Rochester
601 Elmwood Ave
Box MCH
Rochester, New 14642
brian_mcgarry@urmc.rochester.edu

Katherine Wen
Vanderbilt University
300 Calhoun Hall
2301 Vanderbilt Place
Nashville, TN 37235
katherine.j.wen@vanderbilt.edu

Huizi Yu
University of Michigan
huizi_yu@yahoo.com

Sarah Berry
Hebrew Senior Life
SarahBerry@hsl.harvard.edu

Vincent Mor
Box G-S121-6
Department of Health Services, Policy & Practice
Brown University School of Public Health
Providence, RI 02912
Vincent_Mor@brown.edu

Maggie Syme
Massachusetts General Hospital
msyme@mgh.harvard.edu

Elizabeth White
Brown University
elizabeth_white@brown.edu

1 Introduction

Shortages and rapid turnover of staff are among the deepest problems facing managers of health care facilities. According to recent forecasts, hundreds of thousands of additional physicians (Markit, 2021), nurses (Buerhaus, 2021) and lower wage staff such as Certified Nursing Assistants (CNAs) and home health aides (Creapeau, Johs-Artisensi and Lauver, 2022) will be needed just in the United States to keep up with demand for care. This shortage is especially acute for lower wage workers, where demand is predicted to rise by over 10% to 10.7 million workers by 2026, yet over 3 million net workers are predicted to leave the labor force (Bateman et al., 2021). Competition for the limited supply of staff combined with staff exit from the industry due to low wages, burnout, job difficulty and other factors have led to staff shortages and extremely high turnover in recent years. This is especially true in the nursing home industry, where facilities are often under-staffed (Geng, Stevenson and Grabowski, 2019) to the point that regulators are imposing staffing minimums (Lin, 2014), increasing minimum wages (Ruffini, 2022; Gandhi and Ruffini, 2022; Legislature, 2023), or offering facilities bonus payments (Gandhi et al., 2024) in attempts to improve staffing. Once staff are hired, retaining them is difficult; typical annual turnover was around 100% prior to the pandemic (Gandhi, Yu and Grabowski, 2021) and has only gotten worse, increasing by 25% between 2021 and 2022 (American Health Care Association, 2023*b*). Nursing home staff turnover is now double that of hospitals (Bergman, 2023), where staff shortages and the use of travel nurses have drawn attention (Hawryluk and Bichell, 2020; Gottlieb and Zenilman, 2024). A recent survey identified staff turnover as the single largest issue facing senior administrators of long-term care facilities (Bryant, 2017).

The COVID-19 pandemic caused many healthcare staff to burn out due to increased patient load and job stress, fear of infection, and other factors (Rizzo et al., 2023). This proved highly problematic for the nursing home industry, where both levels (Gorges and Konetzka, 2020) and consistency (Loomer et al., 2022) of staffing play a critical role in infection control and preventing outbreaks among highly vulnerable nursing home resident populations. Due to close proximity of patients and staff, health care facilities became focal points of infection that devastated patients and staff alike (Shen et al., 2022). Nowhere was this more true than nursing homes: in the first year of the pandemic, over 1,300 nursing homes had infection rates among patients of over 75%, and mortality rates of the old and infirm patients at these high-infection facilities averaged over 20% (Office of Inspector General, 2023). To make matters worse, COVID-19 outbreaks within nursing homes were found to spur staff departures (Shen et al., 2022), potentially creating a vicious cycle where decreased staffing after an outbreak would place facilities at increased risk for a another outbreak.

Vaccines held the promise to help break this vicious cycle (Polack et al., 2020; McGarry et al., 2022*b*), yet facility managers faced a difficult problem: vaccination rates among staff lagged that of patients and other vaccine-eligible population members (McGarry et al., 2021*b*). Vaccine hesitancy—both in general and specifically for COVID—is strongest among non-white and low-income individuals, the dominant demographic for low-wage health staff that make up the majority of health care personnel (Liu and Li, 2021). Increasing vaccine coverage was strikingly difficult, with one randomized control trial involving 133 facilities and nearly 18,000 staff finding no statistically significant effect of soft-touch approaches—such as educational materials, town hall meetings, and messaging from community leaders—to improve vaccinations among staff (Berry et al., 2022).

Despite evidence that vaccine mandates are effective at increasing vaccination coverage (Abrevaya and Mulligan, 2011; Lawler, 2017; Carpenter and Lawler, 2019), facility administrators were reluctant to implement the hard-line approach of mandates, reporting fears that mandates could worsen already high turnover or even result in staff shortages (Gardner, 2022). Facilities risked losing large numbers of vaccine hesitant staff, which could even snowball into losing vaccinated staff if departures of non-complying staff increased workload and stress for others. While there is evidence that state-level vaccine mandates for health care workers are effective and do not cause large turnover (McGarry et al., 2022*a*), a facility-level mandate is fundamentally different, as employees hesitant to take the vaccine could much more easily find a job at a nearby facility without a mandate. Interviews of facility administrators (Gadbois et al., 2023) suggest that while some nursing homes implemented their own vaccine mandates, most facilities did not due to the "fear that staff would leave for facilities where vaccination was not required." These facilities' administrators often "were in favor of a federal mandate, which made the government the 'bad guy' instead of them."

This variation between facilities that did and did not implement their own mandates provides a compelling quasi-experiment on the health and employment effects of employer-imposed vaccination mandates. Studying this tradeoff helps us to answer one of the most important managerial questions facing administrators at health facilities: in the face of workforce challenges such as staff shortages, high turnover, and a very tight labor market, is it worthwhile for managers to impose a practice that enhances patient and worker safety but is disliked by some staff? Imposition of a mandate is likely to reduce COVID transmission at the facility. Indeed, prior research has documented that state laws that require influenza vaccination among hospital employees were associated with reductions in influenza and pneumonia mortality (Carrera, Lawler and White, 2021). However, because staffing levels are so critical to patient health and quality of care (Lin, 2014; Friedrich and Hackmann, 2021), if the mandate causes enough workers to leave, it could endanger the very patients it aims to protect.

In this study, we combine several comprehensive databases and employ a quasi-experimental event study design to estimate the effect of a facility-level vaccine mandate at nursing homes. We estimate effects on measures of staff turnover, patient care, and patient health (including but not limited to patient mortality).

We use detailed payroll-based data on nearly 500 million daily nursing staff shifts by over 5 million staff members at nursing homes; comprehensive data on the announcement and introduction of employer-level vaccine mandates at nursing home chains; facility-level data from the Centers for Disease Control and Prevention on vaccination coverage, COVID infections, and COVID-related deaths among residents and staff; and a wide variety of patient outcomes associated with the level of care (e.g., injuries from falls, pressure ulcers, etc). We also use data on concentration of nursing homes within a geographic area and patient demographics at facilities to examine the effects of labor market concentration and equity, respectively. To our knowledge, this is the first comprehensive, quasi-experimental study of the effects of employer-imposed vaccine mandates on health, worker turnover, and the efficacy of a vaccine mandate in a labor market with chronic shortages.

We find large, positive effects of employer-level mandates on vaccine uptake by staff. This had life-saving spillovers on the health of nursing home residents, who saw a reduction in both COVID cases and mortality. For every two facilities that issued a mandate, approximately one life was saved. Given that the typical facility has only 100 residents, this is a large effect. While we do find a statistically significant increase in turnover and decrease in staff time spent on patient care at mandate-issuing facilities, the magnitude of these effects is small. For example, the mandates reduced patient care by about two minutes per patient-day, which is just 1.4% of the mean. Also, the additional separations are concentrated among part-time staff working less than 20 hours a week at a facility. Turnover among such staff is already common and is likely to be less disruptive than separations of full-time staff (Kesavan, Staats and Gilland, 2014; Clemens et al., 2021). Quite tellingly, we find very limited evidence of reductions in care when examining conditions typically considered to indicate poor quality care such as injuries from falls, urinary tract infections, and pressure ulcers. Interestingly, we find that the concentration of nursing homes in a geography is not correlated with mandate-induced turnover, suggesting geographic labor market competition is not a major mediator in whether or not vaccine hesitant staff choose to comply. Finally, and worryingly, we find that existing inequalities in health care may be exacerbated by employer-level mandates: facilities in richer locations with a higher concentration of white residents are more likely to issue mandates, and as a result, lower income patients and patients of color are less likely to benefit from the mortality reductions caused by the mandates.

This paper makes several important contributions. As noted, it is to our knowledge the first comprehensive, quasi-experimental study that investigates the tradeoffs between patient health and employer turnover when issuing vaccine mandates. However, it also speaks to the broader theoretical and managerial questions around optimal management of health care facilities in the face of staff turnover. Human resource management at its core involves consideration of the tradeoffs between employer requirements and the preferences of personnel (Larkin, Pierce and Gino, 2012), and many HR policies in health, such as shift allocation, work-day length, job assignment and many others contain the same tradeoffs between efficiently and effectively taking care of patients and ensuring critical personnel achieve sufficient job satisfaction (Platis, Reklitis and Zimeras, 2015). Finally, our study contributes to the ongoing debate on disparities in health care, and how the delegation of policies such as mandates to the private sector—as opposed to mandates and other regulations decided at the government level—may exacerbate existing inequalities in health.

The paper is organized as follows. Section 2 briefly overviews the theoretical logic and existing literature on the tradeoffs of HR policies such as mandates on patient care and employee turnover in health settings. Section 3 describes the nursing home industry and gives details around vaccine mandates. Section 4 outlines the data used in the study, and Section 5 lays out the empirical strategy and results, including robustness checks. Section 6 discusses the results and gives theoretical and managerial implications, study limitations and ideas for future work.

2 Theoretical Background and Related Literature

Ensuring high-quality patient care is paramount to the mission of health care organizations. Frontline workers, who directly interact with patients, are the most important factor affecting care. Therefore, attracting, retaining, and motivating these staff is critical providing high-quality care (Borkowski and Meese, 2020). High rates of employee turnover have been causally linked to worse performance across a variety of industries and contexts (Li et al., 2022). Turnover among direct-care healthcare workers can be particularly damaging and has been linked to variation in process standards that result in poor care and adverse outcomes (Tucker, Nembhard and Edmondson, 2007; Antill et al., 2023; Moscelli et al., 2023). Turnover can also decrease quality of care through increasing variation in team composition (Bartel et al., 2014) and even creating staffing shortages (Friedrich and Hackmann, 2021).

A vaccination mandate could exacerbate turnover if vaccine-hesitant employees choose to depart the organization rather than comply with the mandate. One October 2021 survey of more than one thousand employers found that 75% were concerned about employee turnover in response to a vaccination mandate Mercer (2021). The "job demands-resources model" (JD-R) framework, a prominent theory used to study employee turnover in health and many other settings, posits that both a job's demands and the resources provided determine employee well-being, burnout, and ultimately turnover (Demerouti et al., 2001). Other studies have shown the JD-R framework to be predictive of turnover in a variety of contexts (Bakker and Demerouti, 2007; Fernet, Austin and Vallerand, 2012; Carlson et al., 2017), including for nursing staff specifically (Broetje, Jenny and Bauer, 2020). The framework has also been shown to predict burnout, negative well-being, and quitting of health care workers in response to the COVID-19 pandemic (Zhou et al., 2022).

Requiring an unvaccinated employee to vaccinate represents a substantial demand on that employee, as it requires them to receive a medical treatment that they would not have voluntarily chosen to receive. Indeed, Troiano and Nardi (2021) shows that hesitant individuals' reservations are quite significant and that hesitancy is strongest among demographics typical of nursing home staff: young people, women, ethnic minorities, and individuals with lower education levels, and those of lower socioeconomic status. Employees may regard mandates negatively regardless of vaccination status if mandates are perceived as overbearing, unethical (Gur-Arie, Jamrozik and Kingori, 2021), or unjust (Mengstie, 2020).

The JD-R framework therefore predicts that the substantial demands of vaccination mandates will either result in greater turnover or else require the employer to expend significant resources to compensate for the demands stemming from the mandate, and thereby retain their employees. Assuming the mandate causes some turnover, the net effect of a vaccine mandate on patient health depends on which effect dominates: the reduction in COVID transmission from increased vaccination coverage (Nordström, Ballin and Nordström, 2021; McGarry et al., 2022*b*), or the reduction in patient care caused by the increased turnover. The net effect of a vaccine mandate on patient care is not obvious ex-ante. Freedman et al. (2023) show that the protective effect of vaccines for others—i.e. the "indirect" or "spillover" effects—can vary substantially and need to be estimated specifically for each context. Likewise, the employment effects of mandates may vary by context.

There is a substantial literature on the negative effects of turnover on patient care and customers outside of health care settings. The first part of the literature focuses on the tradeoff between efficiency and care, which is greatly exacerbated by turnover. Care demands in health care are highly stochastic (Kc and Terwiesch, 2009), and adjusting workers' shifts to match this volatility leads to significant turnover (Bergman, David and Song, 2023). Healthcare managers must therefore inherently weigh staff utilization and staff responsiveness (Berry Jaeker and Tucker, 2017). Systems which are optimized towards high utilization can reduce staff responsiveness, leading to a higher number of accidents and fatalities in hospitals and other health care settings (Kuntz, Mennicken and Scholtes, 2015). These systems can also distort care decisions during times of peak demand, leading to suboptimal care (Freeman, Savva and Scholtes, 2017).

Managerial methods to increase flexibility while not harming efficiency can have unintended consequences. For example, one commonly-used method to increase flexibility is the greater use of part-time or contract staff instead of full-time or permanent staff; however, both approaches have been shown to cause declines in patient care (Bourbonniere et al., 2006; Konetzka, Stearns and Park, 2008; Lu and Lu, 2017). Higher turnover makes the management of this tradeoff even more difficult because it reduces both utilization—since new employees are not immediately as productive as those they replaced—and responsiveness because high turnover is associated with greater instances of low staffing levels and reduced performance in times of high or unexpected demand (Ton and Huckman, 2008).

A second mechanism by which turnover harms patient care is behavioral. Staff morale is harmed by high turnover, which can ultimately harm patients through lower quality care, and from inducing even higher rates of turnover as burned out employees leave their job. High turnover and the resulting inflexibility in staffing can also increase stress on employees that remain at an organization (Staw, 1980). For one, workloads on remaining employees can increase, leading to feelings of overwork and burnout (Avey, Luthans and Jensen, 2009). With high turnover, remaining staff are also asked to more frequently work on tasks on which they do not feel as competent or do not like, which reduces job satisfaction (Adler, Skov and Salvemini, 1985; Huckman and Staats, 2011). Finally, workers feel stress and perform less well when colleagues leave the company, particularly when the departure is involuntary or due to a dispute with the employer (Choudhury et al., 2024). Workers who feel stressed are more likely to make mistake (Hunter and Thatcher, 2007). Additionally, stressed workers are themselves more likely to subsequently quit, leading to a snowball effect. The COVID-19 pandemic only exacerbated the stress caused by employee turnover in health care settings; not only did turnover spike during outbreaks at healthcare facilities (Shen et al., 2022), but the pandemic also led to large shocks in patient demand, significant uncertainty, and a huge amount of stress on nurses and other frontline staff (Tolksdorf, Tischler and Heinrichs, 2022).

Management decisions around these tradeoffs causally affect the performance of health care organizations, including around patient care (La Forgia, 2023; Lu and Lu, 2022). Specifically, managers in health care organizations must reduce turnover from sub-optimally high levels and promote desired levels of service (Tan and Netessine, 2014; Dai and Tayur, 2020). Managing this tradeoff is not easy because increasing employee satisfaction reduces both turnover and error rates, but also reduces efficiency (Grant, Christianson and Price, 2007).

The efficiency-care tradeoff has been studied in several previous papers. One prominent example of this effect is found in the overtime laws enacted to protect nurses in many jurisdictions from overly long working hours. These reduced demands led to a higher degree of job satisfaction and less burnout, but also led to reductions in patient care, both in terms of time spent with patients, and in the quality of care given since care was more likely to be provided by part-time or inexperienced staff (Lu and Lu, 2017). Another example is "endogenous absenteeism," where nurses and other health care staff react to the announced schedule to call in sick in times where they anticipate being overworked (Green, Savin and Savva, 2013). Managers face the choice of overscheduling nurses and reducing efficiency, or rationally scheduling and increasing absenteeism, stress on remaining workers, and the incidence of poor quality of care. A third example comes in the turnover effects of "efficient" scheduling, which allows employers to more flexibly react to unforeseen demand. This flexibility can increase care to patients during periods of unexpected demand, but employees often react to the "efficient" practice of increasing schedule volatility by quitting, which reduces patient care (Bergman, David and Song, 2023).

A final related literature is on other factors beyond the focal job's demands and resources that contribute to a decision to leave a job. Like employees in any other industry, employees in health care will consider their job market prospects when deciding whether to leave their current job. A long literature has shown that one of the strongest predictors of turnover is a worker's employment options at other firms (Lee et al., 2008). Turnover is more likely when workers can easily find another job, and this is particularly true when there are many available jobs at the local level, since workers are less likely to depart a job if it requires them to find a new residence in a new geography (Jäger et al., 2024).

3 Institutional Environment

The nursing home industry plays a significant role in the care of a large portion of the population in the United States. There are over 15,000 nursing homes certified by the Centers for Medicare & Medicaid Services (CMS) that serve over 1.2 million patients (Kaiser Family Foundation, 2023), and over 10,000 long-term care facilities not certified by CMS that serve many more older Americans. Close to 5% of Americans aged above 65 live in a nursing home. The size of nursing homes varies, with an average facility having approximately 100 beds. Nearly 70% of nursing home facilities are operated by for-profit companies, with the remainder primarily being nonprofit and a small minority being government-owned.

At any given time, approximately 1.5 million workers are employed at a nursing home, but frequent turnover means that over 3 million individual workers have been employed by a nursing home in the last two years (American Health Care Association, 2023*a*). Over half (53%) of nursing home employees are certified nursing assistants (CNAs); other patient-facing staff include physical, occupational, and speech therapists, licensed practical nurses (LPNs), and registered nurses (RNs). CMS emphasizes the importance of RNs for quality of care in the five-star rating system (Centers for Medicare & Medicaid Services, 2019), but only require that facilities employ eight hours of RN care each day and have at least one RN or LPN on duty at all times. Many but not all states have stricter regulations on staffing levels (Harrington, 2010; Lin, 2014). These are often specified as a minimum number of hours of direct care per patient day overall or by staff type; however, many states require only that there be "sufficient staff to meet resident needs" (Consumer Voice, 2021). While technology can substitute for some staff tasks (Lu, Rui and Seidmann, 2018), the majority of direct patient care must be provided by nursing staff.

The COVID pandemic hit nursing home patients and employees particularly hard. In the early wave of the pandemic, an estimated 42% of COVID deaths nationwide occurred in nursing homes (Abrams et al., 2020). This is unsurprising; as one analysis described, nursing homes represent a "perfect storm" of attributes that would predict COVID spread and mortality (Ouslander and Grabowski, 2020). Residents live in close proximity with each other, often sharing communal spaces, bedrooms and bathrooms, which allows disease to spread between residents. More importantly, nursing home residents require regular assistance with activities of daily living—such as bathing, toileting, and moving—meaning that staff must be in close proximity to assist and provide care to residents. Staff cover many patients within a facility and may even work at multiple facilities (Chen, Chevalier and Long, 2021), allowing a single staff member to potentially infect a large number of patients.

Nursing home patients are highly vulnerable to COVID given that the average resident is over 80 years old and has multiple health comorbidities. By the end of 2020, almost 20% of the nearly 600,000 COVID cases at nursing homes resulted in death (Shen et al., 2021). Although nursing homes took steps to limit exposure, like eliminating family visits and implementing surveillance testing (McGarry, Gandhi and Barnett, 2023), these methods could not entirely prevent deadly outbreaks (Dykgraaf et al., 2021). Even nursing homes taking significant precautions could not prevent all opportunities for COVID to enter the facility. First, newly admitted patients could already be infected (McGarry et al., 2024). Even more importantly, because nursing home staff do not live in facilities they can become infected outside of work and seed outbreaks at the facility (McGarry et al., 2021*a*; Shen, 2022).

As vaccines against COVID were released in December, 2020, health care workers, first responders, and nursing home residents and staff were among the first groups to receive the vaccines. Despite uneven supply and some logistical difficulties in distributing vaccines to the large number of facilities and patients, over 80% of nursing home patients were fully vaccinated within six months of vaccine release (McGarry et al., 2021*b*). In contrast, vaccination rates of employees lagged significantly, with overall vaccination rates of only 60%. Physician and therapist vaccination rates approached that of patients, but less than 50% of CNAs—who interact most closely with patients and constitute the majority of nursing home staff—were vaccinated by July, 2021 (McGarry et al., 2021*b*). Within all roles, employees with shorter tenures and those who were non-white were less likely to vaccinated (McGarry et al., 2021*b*).

Low rates of staff vaccination became a national concern as outbreaks continued to disproportionately devastate facilities with many unvaccinated staff (McGarry et al., 2022*b*). Various mandates were proposed at the state and federal level. These were ultimately highly effective (McGarry et al., 2022*a*; Razzaghi et al., 2022), but passage and enforcement were slow and often met with political and legal challenges. For example, the federal mandate for healthcare worker vaccinations only overcame legal challenges on January 13, 2022 and enforcement only started on February 28, 2022.

In the long period before government mandates, nursing homes were left to address poor staff vaccination themselves. Many facility managers took steps to promote vaccines, including providing educational material, holding town hall meetings with staff, providing gifts such as T-shirts or coffee mugs to vaccinated employees, and undertaking messaging campaigns from community leaders with shared heritage of many staff. A careful randomized control trial (RCT) of six such strategies at skilled nursing facilities across nearly 20,000 staff found these campaigns had no discernible effect on vaccination rates (Berry et al., 2022).

In this context, some nursing homes and chains implemented their own vaccination mandates. These were highly controversial, as their efficacy was uncertain and many worried that that vaccine hesitant staff would quit to work for competitors without mandates (Gadbois et al., 2023). In the following sections, we estimate the effect of these mandates on both the health outcomes of residents as well as on facilities' staffing.

4 Data

4.1 Study period

This study focuses on the employment and health outcomes of nursing home employees and patients at nursing homes that issued an employee vaccine mandate between December 28, 2020 and August 31, 2021. We chose the start of this study period to match the date of the first reported vaccine mandate (December 28, 2020), less than a month after the first COVID vaccines received Emergency Use Authorization. August 31, 2021 was the date of the last reported mandate; on September 4, 2021, the Biden Administration announced that a federal vaccine mandate for health care workers would begin in November, 2021, and it was widely reported even before this date that a nationwide federal mandate was being designed and would be released shortly.

Our study combines data from several sources on nursing home vaccine mandates, employment, and patient health.

4.2 Vaccine Mandates

We collected data on nursing home vaccine mandate announcement date and effective date from McKnights, a leading online publication for senior living (see Appendix A.1). The frequent outbreaks of COVID at nursing homes was a prominent issue in the senior living community, so McKnights staff regularly surveyed nursing home chains—organizations that own more than one nursing home—on their mandate plans, and listed new mandates on a weekly basis. Eighteen chains introduced mandates during the study dates.[1] Five of these

[1]Note that many of the mandates we study had religious, medical or other exemptions, since legal observers believed they were required under state and/or federal law.

chains were excluded due to poor quality payroll data. The thirteen remaining mandate chains consist of 581 nursing homes that announced and implemented mandates during the study period represent the treatment group. The 9,242 nursing homes that did report a mandate to McKnights are the control group. Appendix Figure A7 shows the geographic distribution of facilities with mandates announced during the study period (hereafter "treatment facilities" or "treatment group"), and that of facilities with no mandate (hereafter "control facilities" or "control group").

While we believe McKnights was diligent in identifying and reporting mandates given the prominence of this issue at the time, we cannot definitively rule out that some facilities implemented mandates that were not reported. If so, these facilities would be incorrectly included in our control group and failing to account to their treatment would most plausibly bias our estimates against finding an effect of mandates.

4.3 Nursing home employment and shift data

CMS maintains a Payroll-Based Journal (PBJ) for nursing homes which records all individual staff shifts for all CMS-certified nursing homes at the employee-day level. To ensure adequate within-facility power, we only include facilities with 40 or more beds, but this excludes only a very small number of facilities. During the study period, there were 489 million individual shifts by 5.1 million individual staff members. Because the employee identifier is facility-specific, a staff member who worked at more than one facility in the sample period shows up as a separate employee in the data. The 5.1 million staff member figure is therefore an overcount, as some staff worked at more than one facility.

The data report total hours worked by a given worker on a given day, the worker's role (e.g., CNA, LPN, RN, etc), and whether the worker was paid by an hourly wage, a fixed salary, or via a contract arrangement (for example via an agreement with an employment agency specializing in nursing home staff). We focus our main analysis on CNAs, since they are the most common employee type, and also were by far the least vaccinated group of employees before mandates were issued.

Because we observe a worker's shifts over time within the same facility, we can identify whether a worker is a new hire at a given facility, the date they last worked at a facility, and whether a worker is full-time (35+ hours per week at a given facility), part-time (20-34 hours), or very part-time ($<$ 20 hours). Unfortunately, we do not observe demographic or other information about staff. For analyses using the PBJ data, some control group chains were dropped from the study sample due to PBJ data quality issues; Appendix A.3 describes these exclusions.

CMS also reports basic data on all certified facilities including location, ownership, bed size, and other similar data via the publicly-available Provider Information File.

4.4 Patient health data

We used data from the Center for Disease Control's National Healthcare Safety Network (NHSN) to observe COVID-19-related patient health outcomes at nursing homes. These data, which the CMS required all certified nursing homes to report at the weekly level throughout most of the pandemic, include COVID vaccination, infection and mortality rates for both patients and staff. We do not use mortality rates among staff in our analysis because employee death is very rare in the data. When assessing COVID transmission and mortality, we extend the study period to January 2, 2022. This reflects the lag between vaccination and potential immunity from vaccination.

To study non-COVID dimensions of quality, we use quarterly quality measures from CMS' Nursing Home Compare tool. These measures are based on residents' health assessments and have been shown to strongly represent the quality of care patient provided by a facility (Harrington et al., 2000; Hickey et al., 2005; Omotowa and Hussey, 2020). These negative health outcomes include bladder incontinence (many patients require assistance to use the restroom, and suffer incontinence if staff are slow to help), urinary tract infections, the use of physical restraints on patients, an injury that is the result of a fall (which often occurs when staff fail to provide adequate supervision or support to residents with mobility impairments), the inappropriate use of anti-psychotic medications (a form of chemical restraint), or the presence of pressure ulcers (which can occur if staff do not properly reposition the bodies of mobility-impaired patients, and can be exacerbated by incontinence). We focused specifically on these measures as they are all markers of adequate staffing levels and would be expected to be sensitive to staff shortages resulting from mandate-induced departures.

5 Empirical Analysis

In this section, we use an event study difference-in-differences methodology to estimate the effect of an employer vaccine mandate on employment and health outcomes. This approach extends the two-period difference-in-differences model to estimate treatment effects for each period within an event window. This event study approach leverages the high-frequency nature of our data to estimate the dynamic evolution of mandate effects over time.

Formally, our regression equation is:

$$y_{i,t} = \eta_{t-\tau(i)} M_i + \gamma_i + \theta_t + \epsilon_{i,t} \tag{1}$$

where $y_{i,t}$ represents the outcome of interest for nursing home i in calendar week t. M_i is an indicator for whether nursing home i is subject to a vaccine mandate. $\tau(i)$ represents the announcement or enforcement date of the vaccination mandate, and $t - \tau(i)$ represents the week of the mandate announcement (or enforcement) so that $t - \tau(i)$ signifies the event time during calendar week t. The coefficient η_k represents the estimate of the effect of the mandate announcement (or enforcement) on the outcome variable for event week k relative to a reference period. γ_i is a nursing home fixed effect, and θ_t denotes calendar-week fixed effects. We cluster standard errors at the chain level since the mandates were typically determined at the chain level (Abadie et al., 2023).

For models that examine mandate announcement, our reference period is the week before the announcement. In other words, each η_k represents the estimated difference between treated and control units in event-period k relative to the difference in $k = -1$. For models that examine mandate enforcement, we chose four weeks before enforcement ($k = -4$) as the reference point. This is intended to capture the fact that recommended interval between first and second doses of mRNA vaccines was 3-4 weeks. Thus, staff members may need to receive their first vaccine dose four weeks in advance of the enforcement date in order to be in compliance.

An event study approach does not require that that baseline levels of outcome variables be the same between treated and control units. Instead, it requires "parallel trends," meaning that, on average, the treated units would have followed the same trends in outcomes as the control units had the treated units not been treated. This assumption is inherently untestable since we do not directly observe the counterfactual in which treated units were not treated. However, our estimates do allow us to probe the plausibility of parallel trends. By inspecting the pre-treatment η_k (i.e., $\{\eta_k\}_{k<0}$), we can assess whether treated and control units followed parallel trends prior to the intervention. Insofar as these coefficients do not indicate violations in parallel trends prior to treatment, it suggests that the parallel trends assumption is plausible.

Post-treatment coefficients of η_k (i.e., $\{\eta_k\}_{k\geq 0}$) represent the estimated effect of the mandate on the outcome variables in event-period k relative to the reference period. If pre-trends are similar, violation of the parallel trends assumption would only occur if there were unobserved systematic shocks to outcomes that are contemporaneous to the mandate. We probe this assumption in the robustness section below.

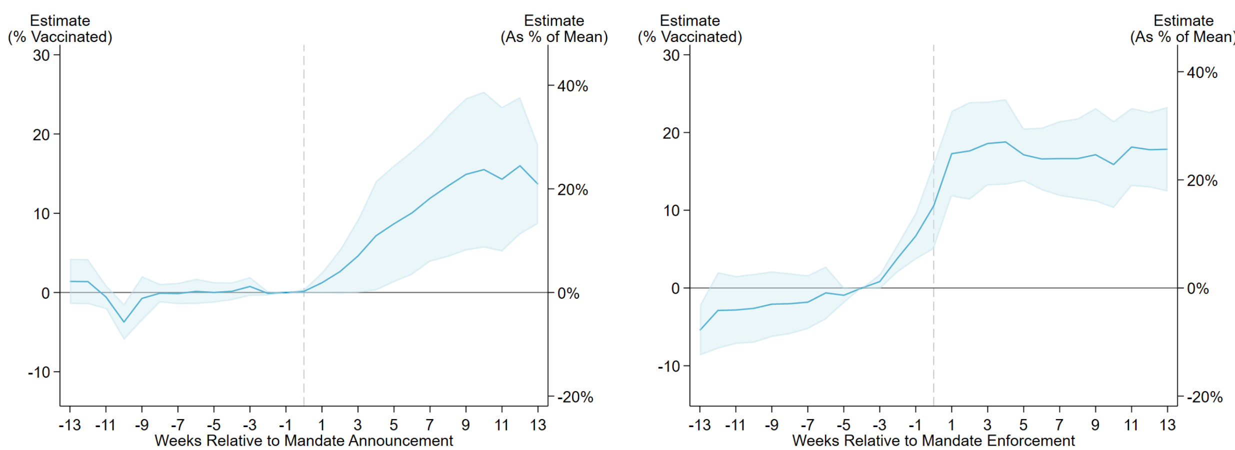
Because not all mandates are implemented on the same date, our estimates may be subject to negative weighting (Goodman-Bacon, 2021). We show that our results are robust to both a stacked approach (Cengiz et al., 2019) and the Callaway and Sant'Anna (2021) estimator. Both approaches avoid negative weighting by ensuring that treated units are only ever compared to control units that have not yet been treated.

5.1 Staff vaccination rates

We first examine the effects of employee vaccination mandates on staff vaccination rates. If fully effective, a mandate should result in all staff being vaccinated. However, it's possible that many employees were able to opt-out or that mandates were not strictly enforced. Therefore, it is worthwhile to assess extent to which mandates actually increased vaccination coverage. Figure 1 shows the estimated effects for each event week (η_k) relative to announcement (panel a) and enforcement (panel b). Relative to contemporaneous changes in control facilities, vaccination at treated facilities increased steadily after the mandate announcement. On average, facilities announcing a mandate saw an increase in vaccination coverage of an additional 13.7 percentage points (21% of the mean) relative to controls by the 13th week after mandate announcement. These estimates suggest that employer mandates were highly effective at increasing vaccination coverage of nursing home staff within a few months of announcement. Our even study estimates show no pre-trends in staff vaccinations, implying that prior to the mandate, both treated and control facilities were experiencing similar trends in staff vaccination.

Figure 1: Estimated Effect of Mandates on Staff Vaccination Rates

(a) Mandate Announcement **(b) Mandate Enforcement**



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in (a) are computed relative to a baseline one week prior to mandate announcement. Estimates in (b) are computed relative to a baseline week that is four weeks prior to the mandate becoming enforced. Four weeks was the authorized interval between first and second dose for the Moderna vaccine. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week. The mean staff vaccination rate in the week prior to mandate announcement was 65.4% (standard deviation [SD]= 15.5). The mean staff vaccination rate in the four weeks prior to mandate enforcement was 69.6% (SD= 14.4).

Panel 1b shows an extremely sharp increase in vaccination at mandate facilities in the four weeks leading up to mandate enforcement. This pattern is highly consistent with a rush to meet the compliance deadline, especially given the four week timeline for receiving a full dose of the Moderna vaccine.[2] The gap in vaccination then flattens out at 17.28% almost immediately after the enforcement date, further confirming that the estimated increase is attributable to staff aiming to meet the compliance deadline.[3]

5.2 Protective Effects of Increased Staff Vaccination

The mandate-induced increase in staff vaccination in Section 5.1 could provide protection that significantly reduces the spread of COVID-19 among the nursing homes' residents and staff. Vaccinated staff are both less likely to contract COVID themselves (Polack et al., 2020) and are less likely to spread it to other staff and residents even when they do (Prunas et al., 2022). Indeed, previous research has shown that nursing homes with higher staff vaccination rates fared much better under the Delta Variant infection waves (McGarry et al., 2022*b*).

In this section, we estimate the protective effects of additional vaccination. For this question in particular, the epidemiological nature of COVID spread makes selection into treatment a particular concern. Specifically, nursing homes experiencing recent or current outbreaks might be more likely to enact staff vaccination mandates. As previously noted, the event study methodology relies on a parallel trends assumption and does not require pre-treatment levels of outcome variables be the same across treatment and control groups. However, for epidemiological outcomes in particular, pre-treatment outcome levels may affect the plausibility of the parallel trends assumption. For example, a facility with a large number of COVID cases immediately prior to mandate announcement may be in the middle of an outbreak. The continuation of this pre-existing outbreak is likely to be the primary driver of trends in the facilities' COVID-related outcomes—such as cases and deaths—in the subsequent weeks. Alternatively, recent outbreaks could also imply higher levels of naturally-acquired immunity among the facility's residents and staff, making it less susceptible to new outbreaks in the future. Therefore, a COVID-naive facility—i.e., one without recent large outbreaks—would make a poor control for a facility that recently experienced an outbreak or that is currently in the middle of one.[4] Insofar as the timing of mandates may be driven by prior or ongoing outbreaks, this could lead to violations of the parallel trends assumption. Similarly, if mandates are implemented because of anticipated outbreaks—e.g., if they are implemented during times when COVID-prevalence in the local community is high—this could also lead to violations in parallel trends.

[2] Note that the slight pre-trends in Panel b are expected and likely represent staff coming into compliance after announcement but well before the enforcement deadline. That vaccination increases particularly sharply immediately prior to the deadline suggests a clear effect from staff trying to meet the deadline.

[3] It is worth noting that while we find the mandates to be highly effective, our estimates do not show treated facilities as achieving 100% vaccination coverage even after the enforcement deadline. This likely reflects imperfect enforcement and the ability of employees to seek religious, medical or other waivers.

[4] Likewise, a facility in the middle of an outbreak or that experienced a recent outbreak would make a poor control for a COVID-naive facility.

To address this potential concern, we follow McGarry et al. (2024) by restricting our controls to an epidemiologically matched sample when analyzing outcomes related to COVID spread. We construct this matched sample so that the control group more closely resembles the treatment group along both geography and recent case rates. COVID outbreaks tend to be highly correlated across facilities within a geographic area because COVID often enters facilities through staff who contract it from the community or from other facilities (Chen, Chevalier and Long, 2021; McGarry et al., 2021*a*; Shen, 2022). To ensure that treated and control units share similar expectations about community case rates, we match each treatment facility only to control facilities in the same county. Second, we matched treatment facilities to neighboring nursing homes that were similar in pre-treatment COVID events. This restriction helps ensure that the epidemiological trajectory of controls plausibly parallels what would have occurred for treated facilities without their mandates.

Matching was conducted using exact matching with replacement on the county where the treatment facility is located and nearest neighbor matching with calipers on three measures of pre-treatment resident COVID case rates (defined as the weekly number of new COVID cases divided by the number of beds in the facility): 1) resident COVID case rates 10-weeks prior to mandate announcement, 2) resident COVID case rates 2-weeks prior to mandate announcement, and 3) the change in resident cases between weeks $\{-4, -3\}$ and $\{-2, -1\}$. This matching helps ensure that mandate facilities are compared to controls that faced similar community prevalence, as well as similar exposure to COVID outbreaks, in the weeks and months leading up to the mandate.

After constructing matched cohorts, we estimated a revised version of the regression in Equation (1), with cohort-specific week and facility fixed effects. These cohort-interacted fixed effects ensure that treatment effects are identified based on difference-in-differences within matched cohorts. Additionally, since transmission may occur from patients, we also include controls for resident COVID vaccination rates. Our findings are robust to excluding these controls.

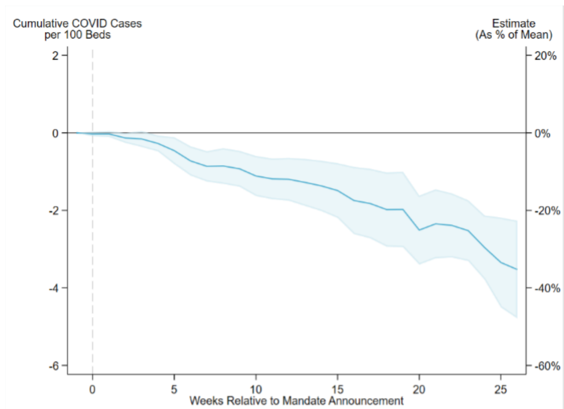
It is important to note that our matched sample consists primarily of facilities on epidemiological trends involving relatively few COVID cases in the weeks immediately prior to mandate announcement. While this does not invalidate our inference, it does affect it's interpretation. Specifically, our estimates in this section is most reflective of the average treatment effect on the treated for facilities with relatively few recent cases. One consequence of this is that the pre-announcement period in the matched sample has very little variation, so we exclude it from our event studies in this section.[5]

Figure 2 presents our estimates on how the epidemiological path of mandate facilities differed after

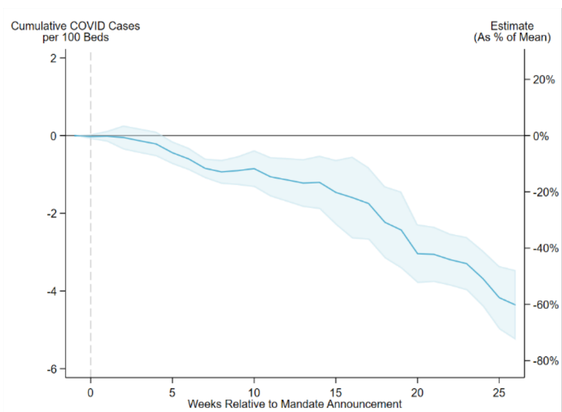
[5]See Appendix Figure B25 for estimates of pre-period trends. The Appendix also shows results for the full sample, which demonstrates directionally similar results to the matched sample but also indicates some differential pre-trends that motivate the use of matching (Appendix Figure B25).

Figure 2: Effect of Mandate Announcement on COVID-19 Cases and Deaths

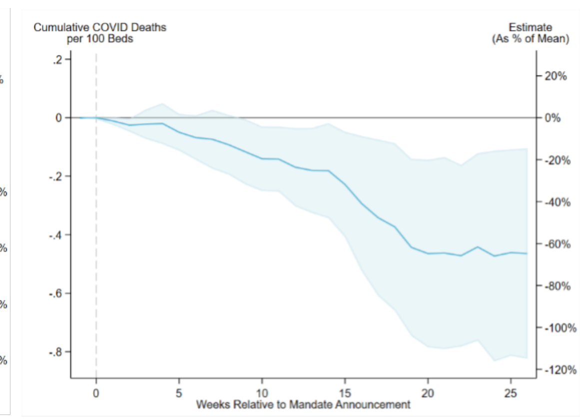
(a) Staff Cases



(b) Resident Cases



(c) Resident Deaths



Notes. These figures plot cumulative event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to a matched control group of nursing homes from the same counties that did not implement a vaccination mandate but were comparable in their recent COVID-19 case rates to the treated facilities. More details on the matching and estimates from the non-cumulative event study, including pre-treatment estimates, are provided in the Appendix Figure B25. Regressions include nursing home by matched cohort and week by matched cohort fixed effects and controls for resident vaccination rates. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for the sample of control facilities if all facilities were observed for the full 26-week follow-up period. The mean number of staff COVID-19 cases per 100 beds for control facilities over 26 weeks of follow up was 10.5 (SD=30.5). The mean number of resident COVID-19 cases and deaths per 100 beds in the week prior to mandate announcement was 8.0 (SD=47.5) and 0.9 (SD=7.7), respectively.

mandate announcement relative to matched non-mandate facilities. The estimates imply that the increase vaccination caused by mandates provided substantial protection against COVID outbreaks. First, we estimate that employer mandates resulted in 3.5 fewer staff COVID cases per 100 beds in the twenty-six weeks after mandate announcement, which is a reduction of 35% of the mean. The mandates also had dramatic spillovers for resident health: 4.4 fewer resident COVID cases per 100 beds, a reduction of 61% of the mean.

Reductions in cases among nursing home residents can have substantial health impacts given that residents' age, frailty, and comorbidities made them comparatively likely to have severe cases resulting in lasting health effects or even death. Indeed, we find that employer-imposed mandates reduced patient deaths by 0.5 per 100 beds, a reduction of 65% of the mean. Since the average facility is about 100 beds, the results mean that the mandates saved one patient life for every two facilities that issued a mandate. Put another way, patients admitted to nursing homes that issued a mandate were two-thirds less likely to die of COVID than patients admitted to similar, geographically proximate nursing homes that did not have a mandate. In addition, these results do not appear to be driven by changes in resident vaccination rates (Appendix Figure B9).

5.3 Employment outcomes

Sections 5.1 and 5.2 showed that employer-imposed mandates were highly effective at increasing vaccination among healthcare workers and providing protection to both patients and staff. However, the imposition of a mandate could lead to greater turnover or even shortages. In this section, we examine whether this is the case among CNA staff, who both constitute the majority of workers and have the lowest vaccination rates. Note that for this this and all remaining analysis, we return to the full sample of control group nursing homes.[6]

Figure 3 shows the effect of employer-imposed mandates on two key employment outcomes for CNAs. Panel a shows the effects on the number of CNA staff working each week. These provide the most direct evidence on the extent to which employer-imposed mandates lead to separations and a reduction in the number of workers. Our estimates suggest that facilities see a small but meaningful reduction in staff size. By thirteen weeks after announcement, the typical 100 bed facility sees a reduction of about 0.73 CNAs, which represents a 4.05% reduction.[7]

Figure 3 panel b shows the effect on the total number of hours worked by CNAs. In order to adjust variation in census across facilities, we normalize hours by the number of patient-days.[8] The effect on hours

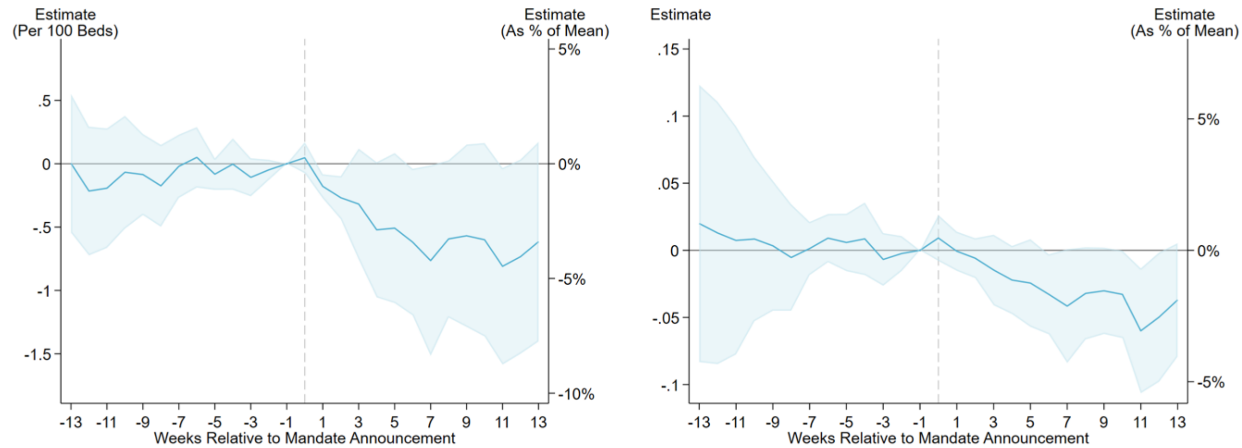
[6] We also carried out all analysis in the paper using the matched sample only. The results are highly similar to that of the full sample, although a few estimates are not statistically significant given the smaller sample size.

[7] For ease of interpretation, we provide our estimates "per 100 beds" since this is the size of a typical facility.

[8] Note that this normalization is standard practice in evaluation staffing at nursing homes. For example, CMS has been using hours per patient day to rate facilities' staffing for decades.

Figure 3: Estimated Effect of Mandate Announcement on CNA Staffing Levels

(a) Staff Size **(b) Hours Per Patient Day**



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week. The mean staff size per 100 beds in the week prior to mandate announcement was 18.1(SD= 5.3). The mean hours per patient day in the week prior to mandate announcement was 1.96(SD= 0.5). Estimates relative to mandate enforcement are shown in Appendix Figure B12.

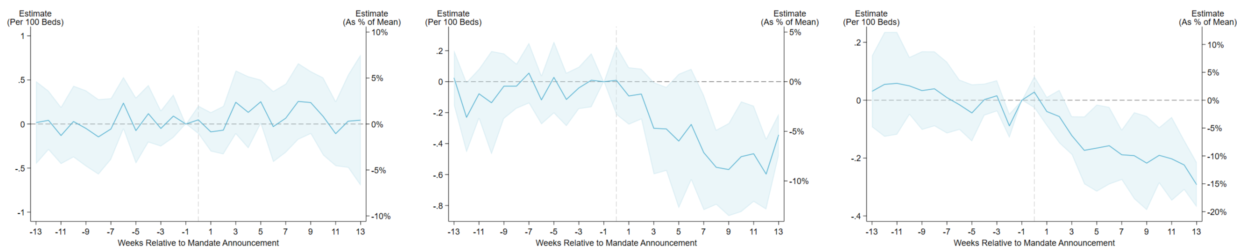
is negative but smaller than the effect on staff size from panel a. This implies that the workers treated facilities lose due to the mandate work shifts that are shorter than the typical worker. We confirm this in Figure 4, which estimates effects separately for full-time (35+ hours per week), part-time (20-34 hours per week), and very-part-time staff (less than 20 hours per week). These estimates show that reductions in staff and hours were concentrated entirely among part-time and very part-time employees. In contrast, the number of full-time staff was unaffected. If anything, full-time staff increased their hours worked, likely to compensate for the small reduction in part-time and very part-time staff. This difference in effects suggests that employees working fewer hours were more willing to separate over the mandate. This may reflect that the financial value of the employment relationship is smaller for low-hours workers. It may also reflect the likelihood that many low-hours workers also work additional jobs with other employers, mitigating the risks of separating from an employer imposing a mandate.

The difference in effects for full- and part-time workers suggests that workers' outside options might mediate employment effects. We investigate this further by contrasting effects in concentrated (above-median HHI) and competitive (below-median HHI) labor markets. Interestingly, Appendix Figure B24 shows negligible difference in the effect of mandates on facilities in concentrated and competitive markets. Contrasting this null effect with the clearer difference between full- and part-time workers suggests that workers' relationship with their employer is a more important factor in compliance than the general level of

Figure 4: Estimated Effect of Mandate Announcement on CNA Staffing Levels by Staff Type

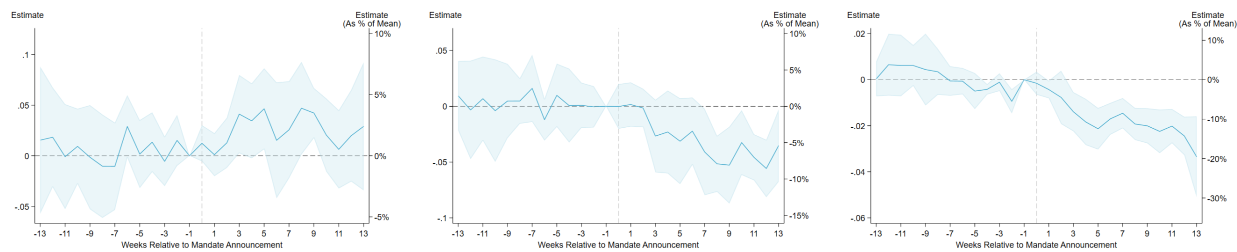
Staff Size

(a) Full-time Staff **(b) Part-time Staff** **(c) Very Part-time Staff**



Hours Per Patient Day

(d) Full-time Staff **(e) Part-time Staff** **(f) Very Part-time Staff**



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week. Full-time staff are those working 35+ hours per week, part-time staff are those working 20-34 hours per week, and very part-time staff are those working fewer than 20 hours per week.

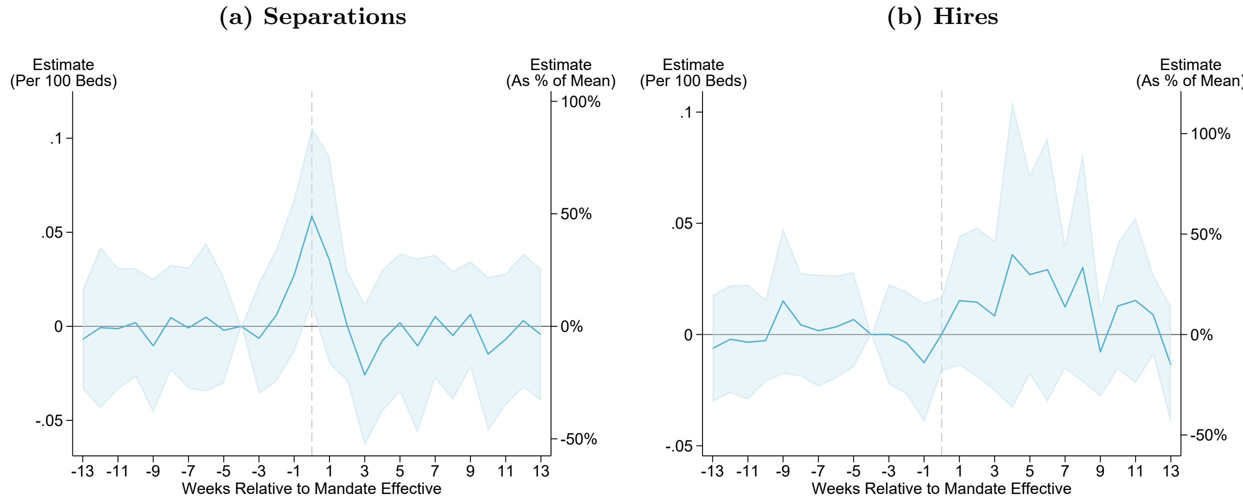
labor market competition.

Finally, Figure 5 shows some of the channels and time dynamics by which our estimated staff reductions occur by separately examining separations and hires.[9] Panel a shows a marked spike in separations at mandate facilities precisely at the time of mandate enforcement, indicating that some non-compliant employees worked at the facility up until the mandate policy forced them to depart. Panel b shows a less sharp increase in hiring at mandate facilities in the weeks following mandate enforcement. The weekly coefficients are not significant at the 5% level since the effects on additional hiring are likely spread out over many weeks. However, the point estimates are suggestive of facilities slightly increasing hiring after enforcement to replace workers who separated due to the mandate.

The Appendix reports myriad other employment-related results. These include results for LPNs (Appendix Figures B20 and B21) and RNs (Appendix Figures B22 and B23), results by employee tenure (Ap-

[9]We identify separations in the PBJ by an employee ID ceasing to appear at a facility and hires by an employee ID appearing at a facility for the first time.

Figure 5: Estimated Effect of Mandate Enforcement on CNA Separations and Hiring



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline week that is 4 weeks prior to the mandate becoming enforced. Four weeks was the authorized interval between first and second dose for the Moderna vaccine. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week. The mean number of separations per 100 beds in the week prior to mandate enforcement was 0.11(SD=0.16). The mean number of hires per 100 beds in the week prior to mandate enforcement was 0.09(SD= 0.18). Estimates relative to mandate announcement are shown in Appendix Figure B15

pendix Figures B17 and B18), results for contract workers only (Appendix Figure B19), results using the matched event study sample (Appendix Figures B8 and B10), and results that constrain the control group to include only chain facilities (Appendix Figures B11 and B14). None of these results meaningfully alter our conclusions. Where they deviate, we typically either observe even smaller effects on staffing or slightly larger standard errors.

5.4 Measures of Patient Care

Section 5.3 suggests that employer-imposed vaccine mandates reduced nursing home staff size and hours from part-time and very-part-time staff. These reductions were quite modest, amounting to approximately 2 minutes of CNA care per patient day. However, given the demonstrable importance of staffing (Friedrich and Hackmann, 2021), even modest reductions could plausibly impact care. Moreover, it's possible staff who complied with the mandate continued to work a similar number of hours but did so with less effort than before. This, too, would result in lower quality care and harms to patients.

We investigate these possibilities in Figure 6, which shows the effect of mandate announcement on six adverse patient outcomes thought to be associated with poor quality care resulting from insufficient nursing home staffing levels. Most estimates are close to zero and are not statistically significant. Notably, we do observe a slight increase in bladder incontinence, which could reflect less attention being paid to residents' bodily needs. CNAs, in particular, are needed to provide physical assistance with toileting for many residents. We also see some evidence of a marked increase in use of physical restraints in the quarter after mandate enforcement. This is consistent with new, overburdened, or disgruntled staff relying on physical restraints to deal with patients exhibiting behavioral issues. However, our estimates on physical restraints are quite imprecise and exhibit relatively large standard errors.

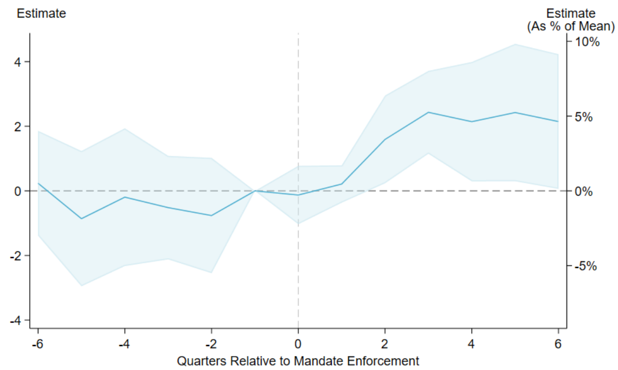
Overall, our estimates do not suggest that patient care suffered dramatically. The relatively small estimated degradation in care pales in comparison to the dramatic positive health effects of increased protection for the facility against COVID-19 outbreaks (Section 5.2). These results are supported by analyses in the Appendix of the result of mandate announcement on overall CMS quality ratings (Appendix Figures B30–B32) and CMS-issued deficiency scores (Appendix Figures B28 and B29), where no significant results were found.

5.5 Robustness checks

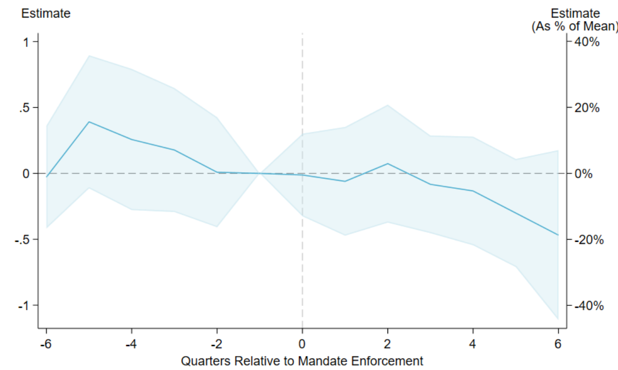
We have already mentioned many robustness checks and sensitivity analyses that can be found in the Appendix, including running analyses using both the full and matched sample, running analyses on samples of RNs (Appendix Figures B22 and B23) and LPNs (Appendix Figures B20 and B21) rather than just CNAs, restricting the control group to chain-owned facilities (Appendix Figures B11 and B14), and running an alternative difference-in-difference estimators that are robust to negative weighting (Appendix Figures B8, B10, B13, and B27).

Figure 6: Effect of Mandate Announcement on Adverse Patient Events

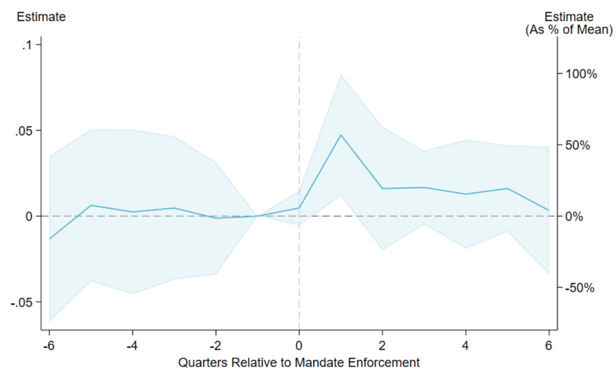
(a) Bladder Incontinence



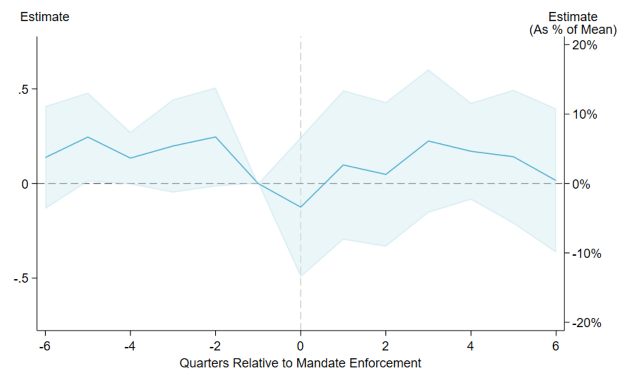
(b) Urinary Tract Infection



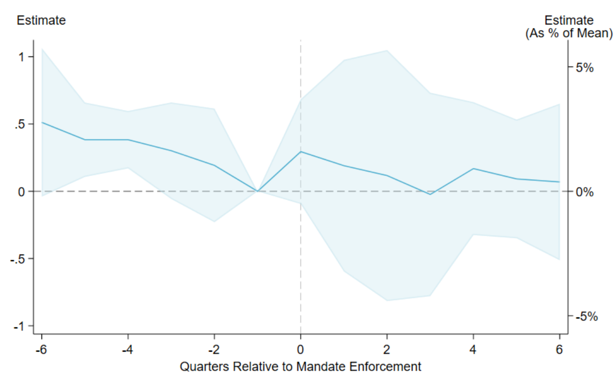
(c) Physically Restrained



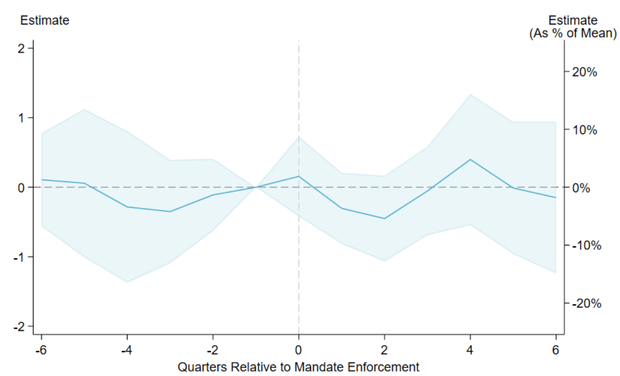
(d) 1+ Falls with Major Injury



(e) Anti-anxiety or Hypnotic Medication



(f) Pressure Ulcer



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline quarter that is one quarter prior to the mandate becoming enforced. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week. All estimates are for nursing home long-stay residents.

6 Discussion

Employer-imposed vaccine mandates were highly effective, and carried very small costs in terms of both staff turnover and patient care. Our results demonstrated that facility managers were able to handle the sharp but relatively small spike in employee separations after the mandate by hiring new staff in the weeks after the mandates were enforced and increasing hours from full-time staff. Furthermore, separations were concentrated among part-time and very part-time staff, and few measurable adverse impacts on patient care, or nursing home quality ratings or deficiency scores, likely because the overall reduction in patient time per staff member was so minimal. These limited effects stand in contrast to the industry-wide fear of mass departure of vaccine-hesitant staff that would cause a cascade of negative consequences in patient care. The effectiveness of mandates in successfully motivating most staff to get vaccinated also stands in contrast to the limited demonstrated effectiveness of less coercive, more persuasion-based measures such as education, outreach and small-scale incentives.

The increases in staff vaccination led to tangible health benefits for both the vaccinated staff and the vulnerable residents they care for – mandate facilities experienced reductions in COVID cases among both staff and residents, and a large reduction in the rates of resident COVID mortality. That vaccines work is extremely well documented. However, this study is the first to our knowledge to show that an employer mandate can increase vaccination to the extent that transmission and death is reduced by approximately two-thirds, with minimal turnover costs even in local labor markets where competitors were not issuing mandates.

The practical policy and managerial implications of our findings are clear, especially because political considerations have made government-issued mandates difficult. Indeed, the uptake of COVID booster shots by the public is extremely small, and as of early 2024, COVID rates are once again on the rise. Furthermore, future COVID variants, unknown future transmissible viruses, and the possibility of other pandemics all point to the importance of our study's results on policies by health care managers. Our results suggest managers should not necessarily wait for slow and often controversial government-level decisions around mandates (Drew, 2022).

Indeed, our results suggest that unwillingness by health care managers to impose mandates can carry significant costs in terms of patient mortality. A back-of-the-envelope extrapolation on our results to the entire population of nursing homes in the U.S. suggests that had all US nursing homes adopted vaccine mandates at the time of the first adopter, nearly 10,000 patient lives could have been saved. If the results were similar across hospitals and the many other types of health care facilities, mandates would save an even greater number of lives.

Our findings have several interesting and important theoretical implications for the management of human capital, both in health care settings and more broadly. First, they suggest scholars have underemphasized the use of human resource policies that at least weakly cause worker disutility, but achieve an important, broader organizational goal such as patient health. The discussion of the HR implications of worker shortages due to morale and burnout in health care settings, as well as in general HR settings, almost exclusively focuses on positive steps firms and managers can take to improve morale and employee well-being. Especially in light of the disconnect between our results and the conventional wisdom on mandated vaccines and turnover, our study suggests that we need to build a greater understanding of how and when potentially unpopular HR policies can be used despite low morale and burnout. It is going to be very difficult for the health care sector to overcome its staffing problems in the short term absent large systemic changes to policies around accreditation, training, immigration and the like, so research attention needs to increase on the question of how HR policies that promote patient care can be crafted in the reality of high turnover. This research augments the much more common focus on HR policies that are designed to reduce stress and thereby turnover.

This paper also has very interesting theoretical implications on one of the fundamental phenomenon studied by labor economists since Lazear (2000): the role of employee sorting. Traditional agency theoretic models of incentives in the workplace, inspired by Holmström (1979), focus on how incentives affect employee effort. Spurred by Lazear's finding that the effect of incentives is determined at least as much by sorting – the decisions of employees of a given type to join or leave a company based on the incentive system used – more recent work has focused less on effort and more on attracting and retaining the right employee. This paper found that separations were concentrated in a single employee type – part-time workers. Although we do not have data to investigate if these employees performed worse than full-time workers, the lack of evidence in reduced patient care even after their separation is at least weakly suggestive of the fact that full-time workers may be "better" in some important sense. Just as the monetary rewards for performance in Lazear led to sorting by quality, with good employees sorting in and bad ones sorting out, the negative reward of a coercive mandate may actually have similar effects. This is a speculative but fascinating avenue for future research.

The results speak to a need to better understand labor market frictions in health care, especially in light of staff shortages. Traditional theory and conventional wisdom holds that workers with better immediate outside employment options will be more likely to leave if the outside option improves relative to their current job. This seemed to happen with part-time workers who presumably already had an outside option with which they had experience. But it did not hold for workers who did not have this personal experience, even in non-concentrated local labor markets with many nursing home competitors chronically short on staff.

The results clearly show the majority of vaccine hesitant workers reacted to mandates by getting vaccinated, especially if they were not working at another facility at the same time. While it could be true that their vaccine hesitancy simply was not very deep, and the psychological cost of getting vaccinated was therefore low, this explanation does not comport with findings that persuasion-based campaigns had no effect on vaccinations. If hesitancy really were low, researchers would expect these campaigns to show at least modest results. Why full-time workers chose this seemingly costly path despite robust labor market alternatives requires great theoretical deliberation.

Finally, the paper speaks to ongoing concerns about inequality in health care. Put bluntly, our results suggest the thousands of patients saved by employer-issued mandates were more likely to be white and to live in suburban and rural areas. Resolving inequality in health care provision and health care outcomes is one of the most challenging issues facing the medical profession (Antwi, Aouad and Blascak, 2023), and our paper provides another cautionary tale around the need to better understand the theoretical drivers of these unequal results.

We hope this paper will spur further investigation into mandates for vaccines and other employee actions that are clearly tied to patient health. There are many employer settings that involve close proximity of employees to each other and/or customers in constrained spaces, including assisted living facilities, hospitals, schools, prisons, mines, manufacturing plants, and even hospitality businesses such as restaurants, discos, movie theaters and sporting venues. Based on recent history, we cannot necessarily expect government policy makers to act quickly or decisively to protect workers and customers in every situation. This underscores the importance of our main finding: mandates by private organizations can and do make a difference.

References

Abadie, Alberto, Susan Athey, Guido W. Imbens, and Jeffrey M. Wooldridge. 2023. "When Should You Adjust Standard Errors for Clustering?" *The Quarterly Journal of Economics*, 138(1): 1–35.

Abrams, Hannah R., Lacey Loomer, Ashvin Gandhi, and David C. Grabowski. 2020. "Characteristics of US nursing homes with COVID-19 cases." *Journal of the American Geriatrics Society*, 68(8): 1653–1656.

Abrevaya, Jason, and Karen Mulligan. 2011. "Effectiveness of state-level vaccination mandates: Evidence from the varicella vaccine." *Journal of Health Economics*, 30(5): 966–976.

Adler, Seymour, Richard B Skov, and Nat J Salvemini. 1985. "Job characteristics and job satisfaction: When cause becomes consequence." *Organizational Behavior and Human Decision Processes*, 35(2): 266–278.

American Health Care Association. 2023*a*. "Long term care jobs report." https://www.ahcancal.org/News-and-Communications/Fact-Sheets/FactSheets/JOBS%20REPORT%20MAY%202023.pdf, last accessed 2024-01-15.

American Health Care Association. 2023*b*. "Nursing home salary and benefits report 2023-24." Hospital & Healthcare Compensation Service and John R. Zabka Associates, Oakland, NJ. Accessed: 2024-01-15.

Antill, Samuel, Jessica Bai, Ashvin Gandhi, and Adrienne Sabety. 2023. "Healthcare Provider Bankruptcies." Working Paper.

Antwi, Yaa Akosa, Marion Aouad, and Nathan Blascak. 2023. "I've Got 99 Problems But a Bill Ain't One: Hospital Billing Caps and Financial Distress in California." *Federal Reserve Bank of Philadelphia Working Paper*, 23(20). Preliminary research, circulated for discussion purposes.

Avey, James B, Fred Luthans, and Susan M Jensen. 2009. "Psychological capital: A positive resource for combating employee stress and turnover." *Human Resource Management*, 48(5): 677–693.

Bakker, Arnold B, and Evangelia Demerouti. 2007. "The Job Demands-Resources model: State of the art." *Journal of Managerial Psychology*, 22(3): 309–328.

Bartel, Ann P, Nancy D Beaulieu, Ciaran S Phibbs, and Patricia W Stone. 2014. "Human Capital and Productivity in a Team Environment: Evidence from the Healthcare Sector." *American Economic Journal: Applied Economics*, 6(2): 231–259.

Bateman, Tanner, Sean Hobaugh, Eric Pridgen, and Arika Reddy. 2021. "US healthcare labor market." Mercer/Marsh and McClellan. https://www.mercer.com/content/dam/mercer/assets/content-images/north-america/united-states/us-healthcare-news/us-2021-healthcare-labor-market-whitepaper.pdf, last retrieved 2024-01-15.

Bergman, Alon, Guy David, and Hummy Song. 2023. ""I Quit": Schedule Volatility as a Driver of Voluntary Employee Turnover." *Manufacturing & Service Operations Management*, 25(4): 1416–1435.

Bergman, Christian. 2023. "Nursing Home Staff Turnover and the Whole-of-Person Framework for Staff Retention." *JAMA Network Open*, 6(10): e2337827.

Berry Jaeker, Jillian A, and Anita L Tucker. 2017. "Past the Point of Speeding Up: The Negative Effects of Workload Saturation on Efficiency and Patient Severity." *Management Science*, 63(4): 1042–1062.

Berry, Sarah D., Keith S. Goldfeld, Kevin McConeghy, David Gifford, H. Edward Davidson, Lisa Han, Maggie Syme, Ashvin Gandhi, Susan L. Mitchell, Jill Harrison, Amy Recker, Kimberly S. Johnson, Stefan Gravenstein, and Vincent Mor. 2022. "Evaluating the findings of the IMPACT-C randomized clinical trial to improve COVID-19 vaccine coverage in skilled nursing facilities." *JAMA Internal Medicine*, 182(3): 324–331.

Borkowski, Nancy, and Katherine A Meese. 2020. *Organizational Behavior in Health Care.* Jones & Bartlett Learning.

Bourbonniere, Meg, Zhanlian Feng, Orna Intrator, Joseph Angelelli, Vincent Mor, and Jacqueline S Zinn. 2006. "The use of contract licensed nursing staff in U.S. nursing homes." *Medical Care Research and Review*, 63(1): 88–109.

Broetje, Sylvia, Gregor J Jenny, and Georg F Bauer. 2020. "The Key Job Demands and Resources of Nursing Staff: An Integrative Review of Reviews." *Frontiers in Psychology*, 11: 84.

Bryant, Olalya Ayanna. 2017. "Employee Turnover in the Long-Term Care Industry." PhD diss. Walden Dissertations and Doctoral Studies, https://scholarworks.waldenu.edu/dissertations/3389, last retrieved 2024-01-15.

Buerhaus, Peter I. 2021. "Current nursing shortages could have long-lasting consequences: Time to change our present course." *Nursing Economics*, 39(5): 247–250.

Callaway, Brantly, and Pedro H. Sant'Anna. 2021. "Difference-in-differences with multiple time periods." *Journal of Econometrics*, 225(2): 200–230.

Carlson, John R, Dawn S Carlson, Suzanne Zivnuska, Ranida B Harris, and Kenneth J Harris. 2017. "Applying the job demands resources model to understand technology as a predictor of turnover intentions." *Computers in Human Behavior*, 77: 317–325.

Carpenter, Christopher S, and Emily C Lawler. 2019. "Direct and spillover effects of middle school vaccination requirements." *American Economic Journal: Economic Policy*, 11(1): 95–125.

Carrera, Mariana, Emily C Lawler, and Corey White. 2021. "Population mortality and laws encouraging influenza vaccination for hospital workers." *Annals of Internal Medicine*, 174(4): 444–452.

Cengiz, Doruk, Arindrajit Dube, Attila Lindner, and Ben Zipperer. 2019. "The Effect of Minimum Wages on Low-Wage Jobs." *The Quarterly Journal of Economics*, 134(3): 1405–1454.

Centers for Medicare & Medicaid Services. 2019. "CMS Improving Nursing Home Compare in April 2019." *https://www.cms.gov/newsroom/fact-sheets/cms-improving-nursing-home-compare-april-2019*, Accessed: 2024-06-10.

Chen, M. Keith, Judith A. Chevalier, and Elisa F. Long. 2021. "Nursing home staff networks and COVID-19." *Proceedings of the National Academy of Sciences*, 118(1): e2015455118.

Choudhury, Prithwiraj, Kirk Doran, Astrid Marinoni, and Chungeun Yoon. 2024. "Loss of Peers and Individual Worker Performance: Evidence From H-1B Visa Denials." *Organization Science*.

Clemens, Sara, Walter Wodchis, Katherine McGilton, Kimberlyn McGrail, and Meghan McMahon. 2021. "The relationship between quality and staffing in long-term care: A systematic review of the literature 2008-2020." *International Journal of Nursing Studies*, 122: 104036.

CMS. 2021*a*. "Biden-Harris Administration Takes Additional Action to Protect America's Nursing Home Residents from COVID-19."

CMS. 2021*b*. "Biden-Harris Administration to Expand Vaccination Requirements for Health Care Settings."

CMS. 2023. "Design for Care Compare Nursing Home Five-Star Quality Rating System: Technical Users' Guide."

Consumer Voice. 2021. "State nursing home staffing standards chart." Appendix B Technical Report. https://theconsumervoice.org/uploads/files/issues/CV_StaffingReport_AppB_Chart.pdf, last accessed 2024-01-15.

Creapeau, Lindsey J., Jennifer L. Johs-Artisensi, and Kristy J. Lauver. 2022. "Leadership and staff perceptions on long-term care staffing challenges related to certified nursing assistant retention." *JONA: The Journal of Nursing Administration*, 52(3): 146–153.

Dai, Tinglong, and Sridhar Tayur. 2020. "OM Forum—Healthcare Operations Management: A Snapshot of Emerging Research." *Manufacturing & Service Operations Management*, 22(5): 869–887.

Demerouti, Evangelia, Arnold B Bakker, Friedhelm Nachreiner, and Wilmar B Schaufeli. 2001. "The job demands-resources model of burnout." *Journal of Applied Psychology*, 86(3): 499–512.

Drew, Liam. 2022. "Did COVID Vaccine Mandates Work? What the Data Say." *Nature*, 607: 22–25.

Dykgraaf, Sally H., Sethunya Matenge, Jane Desborough, Elizabeth Sturgiss, Garang Dut, Leslee Roberts, Alison McMillan, and Michael Kidd. 2021. "Protecting nursing homes and long-term care facilities from COVID-19: a rapid review of international evidence." *Journal of the American Medical Directors Association*, 22(10): 1969–1988.

Fernet, Claude, Stéphanie Austin, and Robert J Vallerand. 2012. "The effects of work motivation on employee exhaustion and commitment: An extension of the JD-R model." *Work & Stress*, 26(3): 213–229.

Freedman, Seth, Daniel W. Sacks, Kosali Simon, and Coady Wing. 2023. "Direct and indirect effects of vaccines: Evidence from COVID-19." *Working Paper*. https://pti.iu.edu.

Freeman, Michael, Nicos Savva, and Stefan Scholtes. 2017. "Gatekeepers at Work: An Empirical Analysis of a Maternity Unit." *Management Science*, 63(10): 3147–3167.

Friedrich, Benjamin U, and Martin B Hackmann. 2021. "The returns to nursing: Evidence from a parental-leave program." *The Review of Economic Studies*, 88(5): 2308–2343.

Gadbois, Emily A., Joan F. Brazier, Amy Meehan, Caroline Madrigal, Elizabeth M. White, Aseel Rafat, David Grabowski, and Renee R. Shield. 2023. "COVID-19 Vaccination Among Skilled Nursing Facility Staff: Challenges and Strategies Identified by Administrators." *Medical Care Research and Review*, 10775587231168435.

Gandhi, Ashvin, and Krista Ruffini. 2022. "Minimum wages and employment composition." Working Paper.

Gandhi, Ashvin, Andrew Olenski, Krista J. Ruffini, and Karen Shen. 2024. "Alleviating Worker Shortages Through Targeted Subsidies: Evidence from Incentive Payments in Healthcare." *NBER Working Paper*, , (32412).

Gandhi, Ashvin, Huizi Yu, and David C. Grabowski. 2021. "High Nursing Staff Turnover In Nursing Homes Offers Important Quality Information." *Health Affairs*, 40(3): 384–391.

Gardner, Sandy. 2022. "The impact of the COVID-19 vaccine mandate on the nursing profession." *ABA Health eSource*, 18(11).

Geng, Fangli, David G Stevenson, and David C Grabowski. 2019. "Daily nursing home staffing levels highly variable, often below CMS expectations." *Health Affairs*, 38(7): 1095–1100.

Goodman-Bacon, Andrew. 2021. "Difference-in-differences with variation in treatment timing." *Journal of Econometrics*, 225(2): 254–277.

Gorges, Rebecca J, and R Tamara Konetzka. 2020. "Staffing Levels and COVID-19 Cases and Outbreaks in U.S. Nursing Homes." *Journal of the American Geriatrics Society*, 68(11): 2462–2466.

Gottlieb, Joshua D, and Avi Zenilman. 2024. "When nurses travel: labor supply elasticity during COVID-19 surges." *University of Chicago, Becker Friedman Institute for Economics Working Paper*.

Grant, Adam M, Marlys K Christianson, and Richard H Price. 2007. "Happiness, Health, or Relationships? Managerial Practices and Employee Well-Being Tradeoffs." *Academy of Management Perspectives*, 21(3): 51–63.

Green, Linda V, Sergei Savin, and Nicos Savva. 2013. "“Nursevendor Problem”: Personnel Staffing in the Presence of Endogenous Absenteeism." *Management Science*, 59(10): 2237–2256.

Gur-Arie, Rachel, Euzebiusz Jamrozik, and Patricia Kingori. 2021. "No Jab, No Job? Ethical Issues in Mandatory COVID-19 Vaccination of Healthcare Personnel." *BMJ Global Health*, 6(2).

Harrington, Charlene. 2010. "Nursing home staffing standards in state statutes and regulations." *University of California San Francisco, Department of Social and Behavioral Sciences*.

Harrington, Charlene, David Zimmerman, Sarita L. Karon, James Robinson, and Patricia Beutel. 2000. "Nursing home staffing and its relationship to deficiencies." *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 55(5): S278–S287.

Hawryluk, Markian, and Rae Ellen Bichell. 2020. "Highly Paid Traveling Nurses Fill Staffing Shortages During COVID Pandemic." *KFF Health News*. Accessed: 2024-04-15.

Hickey, Elaine C., Gary J. Young, Victoria A. Parker, Elaine J. Czarnowski, Debra Saliba, and Dan R. Berlowitz. 2005. "The effects of changes in nursing home staffing on pressure ulcer rates." *Journal of the American Medical Directors Association*, 6(1): 50–53.

Holmström, Bengt. 1979. "Moral hazard and observability." *The Bell Journal of Economics*, 74–91.

Huckman, Robert S, and Bradley R Staats. 2011. "Fluid Tasks and Fluid Teams: The Impact of Diversity in Experience and Team Familiarity on Team Performance." *Manufacturing & Service Operations Management*, 13(3): 310–328.

Hunter, Larry W., and Sherry M. B. Thatcher. 2007. "Feeling the Heat: Effects of Stress, Commitment, and Job Experience on Job Performance." *Academy of Management Journal*, 50(4): 953–968.

Jäger, Simon, Christopher Roth, Nina Roussille, and Benjamin Schoefer. 2024. "Worker Beliefs About Outside Options." *The Quarterly Journal of Economics*.

Kaiser Family Foundation. 2023. "Total Number of Residents in Certified Nursing Facilities." KFF analysis of CMS Care Compare data. https://www.kff.org/other/state-indicator/number-of-nursing-facility-residents/, last accessed 2024-01-15.

Kc, Diwas S, and Christian Terwiesch. 2009. "Impact of Workload on Service Time and Patient Safety: An Econometric Analysis of Hospital Operations." *Management Science*, 55(9): 1486–1498.

Kesavan, Saravanan, Bradley R Staats, and Wendell Gilland. 2014. "Volume Flexibility in Services: The Costs and Benefits of Flexible Labor Resources." *Management Science*, 60(8): 1884–1906.

Konetzka, R Tamara, Sally C Stearns, and Jeongyoung Park. 2008. "The staffing-outcomes relationship in nursing homes." *Health Services Research*, 43(3): 1025–1042.

Kuntz, Ludwig, Roman Mennicken, and Stefan Scholtes. 2015. "Stress on the Ward: Evidence of Safety Tipping Points in Hospitals." *Management Science*, 61(4): 754–771.

La Forgia, Ambar. 2023. "The Impact of Management on Clinical Performance: Evidence from Physician Practice Management Companies." *Management Science*, 69(8): 4646–4667.

Larkin, Ian, Lamer Pierce, and Francesca Gino. 2012. "The psychological costs of pay-for-performance: Implications for the strategic compensation of employees." *Strategic Management Journal*, 33(10): 1194–1214.

Lawler, Emily C. 2017. "Effectiveness of vaccination recommendations versus mandates: Evidence from the hepatitis A vaccine." *Journal of Health Economics*, 52: 45–62.

Lazear, Edward P. 2000. "Performance pay and productivity." *American Economic Review*, 90(5): 1346–1361.

Lee, Tae Heon, Barry Gerhart, Ingo Weller, and Charlie O Trevor. 2008. "Understanding Voluntary Turnover: Path-Specific Job Satisfaction Effects and The Importance of Unsolicited Job Offers." *Academy of Management Journal*, 51(4): 651–671.

Legislature, California. 2023. "Senate Bill 525: Minimum wages for health care workers." *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB525*, Chaptered by Secretary of State. Chapter 890, Statutes of 2023.

Lin, Haizhen. 2014. "Revisiting the relationship between nurse staffing and quality of care in nursing homes: An instrumental variables approach." *Journal of Health Economics*, 37: 13–24.

Li, Qin, Ben Lourie, Alexander Nekrasov, and Terry Shevlin. 2022. "Employee turnover and firm performance: Large-sample archival evidence." *Management Science*, 68(8): 5667–5683.

Liu, Ran, and Gabriel M. Li. 2021. "Hesitancy in the time of coronavirus: Temporal, spatial, and sociodemographic variations in COVID-19 vaccine hesitancy." *SSM-population health*, 15: 100896.

Loomer, Lacey, David C Grabowski, Huizi Yu, and Ashvin Gandhi. 2022. "Association between nursing home staff turnover and infection control citations." *Health Services Research*, 57(2): 322–332.

Lu, Lauren Xiaoyuan, and Susan Feng Lu. 2022. "Does Nonprofit Ownership Matter for Firm Performance? Financial Distress and Ownership Conversion of Nursing Homes." *Management Science*, 68(7): 5127–5145.

Lu, Susan Feng, and Lauren Xiaoyuan Lu. 2017. "Do Mandatory Overtime Laws Improve Quality? Staffing Decisions and Operational Flexibility of Nursing Homes." *Management Science*, 63(11): 3566–3585.

Lu, Susan F., Huaxia Rui, and Abraham Seidmann. 2018. "Does Technology Substitute for Nurses? Staffing Decisions in Nursing Homes." *Management Science*, 64(4): 1842–1859. Published online March 28, 2017.

Markit. 2021. "The complexities of physician supply and demand: projections from 2019 to 2034." Association of American Medical Colleges. https://www.aamc.org/media/54681/download?attachment, last retrieved 2024-01-15.

McGarry, Brian E., Ashvin D. Gandhi, and Michael L. Barnett. 2023. "Covid-19 Surveillance Testing and Resident Outcomes in Nursing Homes." *The New England Journal of Medicine*, 388(12): 1101–1110.

McGarry, Brian E, Ashvin D Gandhi, David C Grabowski, and Michael Lawrence Barnett. 2021*a*. "Larger Nursing Home Staff Size Linked To Higher Number Of COVID-19 Cases In 2020: Study examines the relationship between staff size and COVID-19 cases in nursing homes and skilled nursing facilities." *Health Affairs*, 40(8): 1261–1269.

McGarry, Brian E., Ashvin D. Gandhi, Maggie Syme, Sarah D. Berry, Elizabeth M. White, and David C. Grabowski. 2022*a*. "Association of state COVID-19 vaccine mandates with staff vaccination coverage and staffing shortages in US nursing homes." *JAMA Health Forum*, 3(7): e222363.

McGarry, Brian E., Ashvin D. Gandhi, Mah Afroze Chughtai, Jiamin Yin, and Michael L. Barnett. 2024. "Clinical Outcomes After Admission of Patients With COVID-19 to Skilled Nursing Facilities." *JAMA Internal Medicine*. Published online June 3, 2024.

McGarry, Brian E., Karen Shen, Michael L. Barnett, David. C. Grabowski, and Ashvin. D. Gandhi. 2021*b*. "Association of nursing home characteristics with staff and resident COVID-19 vaccination coverage." *JAMA Internal Medicine*, 181(12): 1670–1672.

McGarry, Brian E, Michael L Barnett, David C Grabowski, and Ashvin D Gandhi. 2022*b*. "Nursing home staff vaccination and Covid-19 outcomes." *New England Journal of Medicine*, 386(4): 397–398.

Mengstie, Missaye Mulatie. 2020. "Perceived organizational justice and turnover intention among hospital healthcare workers." *BMC Psychology*, 8(1): 19.

Mercer. 2021. "US Vaccine Mandate Business Impact Pulse Survey." *Online report*, http://app.keysurvey.com/reportmodule/REPORT2/report/41590172/41300632/2ae1e2dd9bbebd12e39d119e567316b7.

Moscelli, Giuseppe, Melisa Sayli, Jo Blanden, Marco Mello, Henrique Castro-Pires, and Chris Bojke. 2023. "Non-Monetary Interventions, Workforce Retention and Hospital Quality: Evidence from the English NHS." 76 Pages, Posted: 21 Aug 2023.

Nordström, Peter, Marcel Ballin, and Anna Nordström. 2021. "Association Between Risk of COVID-19 Infection in Nonimmune Individuals and COVID-19 Immunity in Their Family Members." *JAMA Internal Medicine*, 181(12): 1589–1595.

Office of Inspector General. 2023. "More than a thousand nursing homes reached infection rates of 75 percent or more in the first year of the covid-19 pandemic; better protections are needed for future emergencies." Data Brief OEI-02-20-00491.

Omotowa, Omotayo O., and Leslie C. Hussey. 2020. "Nurse Staffing and Falls Among the Older Adults in Nursing Homes." *Jour Nursing Home Res*, 6: 90–92.

Ouslander, Joseph G., and David C. Grabowski. 2020. "COVID-19 in nursing homes: calming the perfect storm." *Journal of the American Geriatrics Society*, 68(10): 2153–2162.

Platis, Charalampos, Panagiotis Reklitis, and Zimeras Zimeras. 2015. "Relation between job satisfaction and job performance in healthcare services." *PROCEDIA-Social and Behavioral Sciences*, 175: 480–487.

Polack, Fernando P, Stephen J Thomas, Nicholas Kitchin, Judith Absalon, Alejandra Gurtman, Stephen Lockhart, John L Perez, Gonzalo Pérez Marc, Edson D Moreira, Cristiano Zerbini, et al. 2020. "Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine." *New England journal of medicine*, 383(27): 2603–2615.

Prunas, Ottavia, Joshua L Warren, Forrest W Crawford, Sivan Gazit, Tal Patalon, Daniel M Weinberger, and Virginia E Pitzer. 2022. "Vaccination with BNT162b2 reduces transmission of SARS-CoV-2 to household contacts in Israel." *Science*, 375(6585): 1151–1154.

Razzaghi, Hilda, Anup Srivastav, Marie A. de Perio, A. Scott Laney, and Carla L. Black. 2022. "Influenza and COVID-19 Vaccination Coverage Among Health Care Personnel—United States, 2021–22." *Morbidity and Mortality Weekly Report*, 71(42): 1319.

Rizzo, Amelia, Murat Yıldırım, Gülçin G. Öztekin, Alessandro De Carlo, Gabriella Nucera, Łukasz Szarpak, Salvatore Zaffina, and Francesco Chirico. 2023. "Nurse burnout before and during the COVID-19 pandemic: a systematic comparative review." *Frontiers in Public Health*, 11.

Ruffini, Krista. 2022. "Worker earnings, service quality, and firm profitability: Evidence from nursing homes and minimum wage reforms." *Review of Economics and Statistics*, 1–46.

Shen, Karen. 2022. "Relationship between nursing home COVID-19 outbreaks and staff neighborhood characteristics." *PLoS One*, 17(4): e0267377.

Shen, Karen, Brian E McGarry, David C Grabowski, Jonathan Gruber, and Ashvin D Gandhi. 2022. "Staffing Patterns in US Nursing Homes During COVID-19 Outbreaks." *JAMA Health Forum*, 3(7): e222151.

Shen, Karen, Lacey Loomer, Hannah Abrams, David C. Grabowski, and Ashvin Gandhi. 2021. "Estimates of COVID-19 Cases and Deaths Among Nursing Home Residents Not Reported in Federal Data." *JAMA Network Open*, 4(9): e2122885.

Staw, Barry M. 1980. "The Consequences of Turnover." *Journal of Occupational Behaviour*, 1(4): 253–273.

Tan, Tom Fangyun, and Serguei Netessine. 2014. "When Does the Devil Make Work? An Empirical Study of the Impact of Workload on Worker Productivity." *Management Science*, 60(6): 1574–1593.

Tolksdorf, Katharina Herta, Ulla Tischler, and Katherina Heinrichs. 2022. "Correlates of turnover intention among nursing staff in the COVID-19 pandemic: a systematic review." *BMC Nursing*, 21(1): 174.

Ton, Zeynep, and Robert S Huckman. 2008. "Managing the Impact of Employee Turnover on Performance: The Role of Process Conformance." *Organization Science*, 19(1): 56–68.

Troiano, Gianmarco, and Alessandra Nardi. 2021. "Vaccine hesitancy in the era of COVID-19." *Public Health*, 194: 245–251.

Tucker, Anita L, Ingrid M Nembhard, and Amy C Edmondson. 2007. "Implementing New Practices: An Empirical Study of Organizational Learning in Hospital Intensive Care Units." *Management Science*, 53(6): 894–907.

Zhou, Ting, Changshun Xu, Cunliang Wang, Sha Sha, Zhe Wang, You Zhou, Xinran Zhang, Die Hu, Yinqi Liu, Tengfei Tian, Sixiang Liang, Li Zhou, and Qian Wang. 2022. "Burnout and well-being of healthcare workers in the post-pandemic period of COVID-19: a perspective from the job demands-resources model." *BMC Health Services Research*, 22(1): 284.

Appendices

A Supplementary Details on Data and Methods

A.1 Vaccination Mandates

A.1.1 Chain Mandates

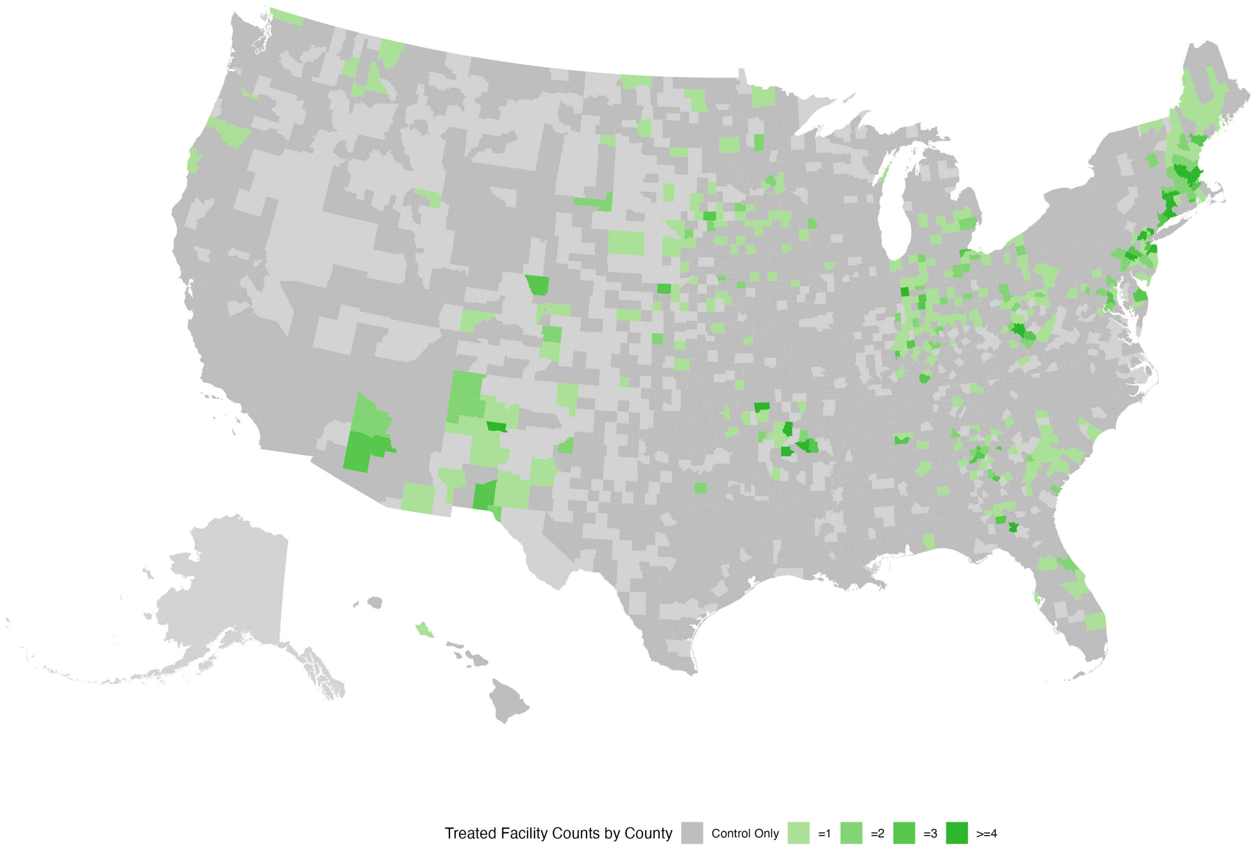
Data on chain mandates was collected from December of 2020 through September of 2021, following the first public announcement of a company-wide COVID-19 vaccination mandate on December 28, 2020. The process for identifying and verifying nursing home chains that implemented COVID-19 vaccination mandates for all employees was as follows. Given the groundbreaking nature of these mandates, a well-known online publication for senior living (McKnights) reported and updated such announcements weekly. We reviewed this and other sites publishing vaccine mandate announcements for updated chain listings. They then searched and collected links to public announcements from each chain to verify, or searched the chain's website for additional information. When further information was not available for verification, the chain's mandate was not added to the verified listing and these chains were excluded from the analysis. We referred to the chains' websites for specific details on the mandates, including the announcement date, enforcement date, and whether it was a mandate for all employees to be vaccinated (excluding medical and religious exemptions).

Table A1: Mandate Announcement and Enforcement Dates

Chain	Announcement Date	Enforcement Date
A	December 28, 2020	February 1, 2021
B	March 15, 2021	June 1, 2021
C	March 23, 2021	July 31, 2021
D	March 31, 2021	June 1, 2021
E	May 13, 2021	May 13, 2021
F	June 1, 2021	September 1, 2021
G	July 1, 2021	August 23, 2021
H	July 14, 2021	September 30, 2021
I	July 22, 2021	November 1, 2021
J	August 2, 2021	August 23, 2021
K	August 9, 2021	October 1, 2021
L	August 16, 2021	November 1, 2021
M	August 31, 2021	October 29, 2021

We obtained provider numbers associated with each chain that implemented a vaccination mandate, which allowed us to merge mandate announcement and enforcement dates with our Payroll-Based Journal (PBJ) and National Healthcare Safety Network (NHSN) data. Figure A7 shows the location of mandate and non-mandate facilities that were included in the sample for employment outcome analyses.

Figure A7: Locations of mandate and non-mandate facilities



Notes. This figure plots the location of mandate (treatment) and non-mandate (control) facilities included in the analyses of employment outcomes. Counties in the lightest gray are those with neither mandate nor non-mandate facilities.

A.1.2 Federal Mandate

The Centers for Medicare and Medicaid (CMS) announced that they were developing emergency regulation of vaccination requirements for staff in nursing homes on August 18, 2021 and announced that they would enact this federal vaccination mandate for all nursing home workers on September 9, 2021, though the regulation was not released until November 4, 2021 (CMS, 2021*a*,*b*).

A.2 Variable Construction

The staffing outcomes of our analysis include staff size (defined as the total number of unique staff working in a given nursing home each day), staffing levels (measured as the number of hours per resident day), staff separations (measured as the number of employees that are last seen in a given nursing home each day), and staffing hires (measured as the number of employees that are first seen in a given nursing home each day).

The scope of our analysis includes CNA (Certified Nurse Aides), LPN (Licensed Practical Nurses), and RN (Registered Nurses). Based on the Technical Users' Guide by Centers for Medicare & Medicaid Services (CMS, 2023), we combine multiple specific job codes for calculating the employment outcomes of each nurse type.

- CNA: Includes Certified Nurse Aides, Aides in Training, and Medication Aides/Technicians
- LPN: Includes Licensed Practical/Licensed Vocational Nurses with Administrative Duties and Licensed Practical/Vocational Nurses
- RN: Includes RN Director of Nursing, Registered Nurses with Administrative Duties, and Registered Nurses

All outcomes (with the exception of hours per resident day) are per 100 beds. We use the number of beds as the denominator specifically because this measure does not change over time. In contrast, a time varying denominator, such as nursing home occupancy, would be problematic because occupancy is likely to be impacted by outbreaks of COVID or other infectious diseases.

A.3 PBJ Data Inclusions and Exclusions

Our analyses of staffing outcomes pertain to nursing home employees since they accounted for the majority of staff; contract workers were excluded. We include nursing homes with 40 or more beds that reported data in the Payroll Based Journal (PBJ) database in 2020 and 2021.

We excluded nursing home with poor quality data reporting in the PBJ database. Table A2 documents the number of mandate and non-mandate nursing homes that were excluded due to poor quality data reporting in PBJ. Nursing homes were excluded if they implemented a software reset, were missing 28+ days of data in 2021, had zero values for staffing outcomes for 7+ days in 2021, or were missing Minimum Dataset census information. For mandate nursing homes, we also excluded nursing homes with no PBJ data available after mandate announcement. Additionally, we excluded all nursing homes belonging to three nursing home chains with a suspected chain-wide software reset in 2019 or 2020. Another chain with an employer vaccination mandate was excluded because of general data quality issues in late 2020.

Additionally, we dropped specific nursing home-days if data quality issues were observed within a two-day window before or after a given day. Such nursing home-days were excluded in 2020 if a nursing home was missing data regardless of length, had zero values for all staffing outcomes for any period, had a temporary decrease in number of workers exceeding 80% from the previous day, or had a MDS census value of zero or missing. Additionally, nursing home-days were excluded if there was missing data for less than 28 days in 2021. Finally, data was censored if a state-level vaccine mandate for healthcare workers in nursing homes was announced.

Table A2: Inclusion Criteria for Mandate & Non-Mandate Facilities

		Number of Mandate Facilities	Number of Non-Mandate Facilities	Total Number of Facilities (Mandate and Non-Mandate)
Inclusions	40+ beds	786	12,749	13,535
	No missing quarters of data for 2020q2 - 2021q4	739	11,336	12,075
Exclusions	PBJ/software reset	663	9,685	10,348
	28+ days of missing data in 2021	663	9,478	10,141
	Staffing outcomes = 0 for 7+ days in 2021	654	9,271	9,925
	MDS census = missing for >0 days in 2021	654	9,242	9,896
	Suspected chain-wide software reset	603	9,242	9,845
	Missing PBJ data post mandate announcement	583	9,242	9,825
	Miscellaneous data quality issues	581	9,242	9,823

A.4 Comparison of treatment and control groups

Table A3 shows summary statistics for pre-mandate means of key variables for our treatment and control groups, for both the full and matched samples. The majority (58%) of treatment group facilities were successfully matched and included in the matched sample, but most control group facilities are not included in the matched sample. Most control group facilities were dropped because they were not geographically proximate to a treatment group facility.

Table A3: Summary Statistics of Mandate and Non-Mandate Nursing Homes

	Full Sample[a]		Matched Sample[b]		
	(1)	(2)	(3)	(4)	(5)
	Mandate	Non-Mandate	Mandate (Matched)	Non-Mandate (Matched)	|Diff|/SD
Staff Vaccinated (%)	64.91 (15.13)	61.82 (19.03)	65.81 (15.45)	66.92 (18.61)	0.07*
Staff size [c, e]	18.12 (5.32)	19.08 (6.79)	17.89 (5.36)	18.85 (6.91)	0.18*
Hours per Resident Day [d,e]	1.96 (0.47)	2.13 (0.57)	1.91 (0.38)	2.05 (0.57)	0.30*
Separations [e]	0.10 (0.15)	0.11 (0.16)	0.09 (0.14)	0.10 (0.15)	0.07*
New Hires [e]	0.08 (0.14)	0.08 (0.16)	0.08 (0.14)	0.09 (0.17)	0.07
Staff Weekly Confirmed COVID-19	0.32 (1.55)	0.25 (1.11)	0.01 (0.13)	0.04 (0.26)	0.02*
Residents Weekly Confirmed COVID-19	0.43 (2.75)	0.22 (1.73)	0.00 (0.00)	0.02 (0.35)	0.01*
Residents Weekly COVID-19 Deaths	0.06 (0.42)	0.03 (0.36)	0.00 (0.00)	0.00 (0.06)	0.00*
Total Cases 10 Weeks Prior	9.13 (21.94)	6.36 (16.29)	1.24 (5.02)	1.85 (7.77)	0.03*
Total Cases 2 Weeks Prior	1.48 (6.58)	0.79 (4.37)	0.02 (0.15)	0.07 (0.47)	0.01*
Change Between {-4,-3} and {-2,-1} Weeks Prior	0.51 (8.86)	0.02 (4.64)	0.01 (0.21)	0.04 (0.72)	0.00*
Beds	100.50 (46.15)	115.17 (62.10)	104.59 (47.43)	112.44 (57.48)	0.17*
Medicaid (%)	60.05 (23.09)	61.30 (21.43)	54.42 (24.12)	60.41 (22.48)	0.26*
Medicare (%)	14.28 (12.65)	12.26 (10.65)	15.26 (12.64)	11.66 (9.77)	0.28*
White (%)	81.50 (22.00)	76.25 (24.37)	84.85 (18.74)	78.13 (21.69)	0.31*
Black (%)	10.74 (18.37)	13.34 (18.55)	8.70 (14.92)	11.76 (16.95)	0.17*
Household Income (Median)	66601.78 (19552.97)	66983.59 (18573.84)	70456.16 (20988.74)	77078.08 (21161.13)	0.34*
Urban (%)	0.65 (0.48)	0.70 (0.46)	0.53 (0.50)	0.87 (0.34)	0.71*
For Profit (%)	0.76 (0.43)	0.73 (0.45)	0.60 (0.49)	0.73 (0.44)	0.30*
Star Rating	3.37 (1.27)	3.28 (1.39)	3.31 (1.34)	3.26 (1.42	0.04
Deficiency Count	9.13 (7.24)	7.71 (7.07)	7.21 (5.83)	7.61 (7.76)	0.06
Deficiency Score	80.65 (109.48)	64.54 (87.01)	65.08 (110.33)	64.42 (102.99)	0.01
Bladder Incontinence (%)	45.96 (15.40)	47.11 (18.25)	48.75 (14.88)	46.51 (19.43)	0.15
Urinary Tract Infection (%)	2.60 (3.19)	2.35 (3.16)	2.72 (3.03)	2.46 (3.30)	0.08
Physically Restrained (%)	0.08 (0.68)	0.18 (1.49)	0.09 (0.61)	0.11 (0.67)	0.03
1+ Falls with Major Injury (%)	3.68 (3.23)	3.35 (2.84)	3.47 (2.94)	3.46 (2.91)	0.00
Anti-Anxiety or Hypnotic Medication (%)	18.54 (9.53)	19.81 (10.36)	17.73 (9.84)	19.40 (9.76)	0.18*
Pressure Ulcer (%)	8.43 (5.54)	8.32 (5.58)	8.52 (5.42)	8.23 (5.46)	0.05
Facilities	581	9,242	224	814	

[a] This sample consists of facilities with high-quality reporting in the PBJ (see Supplementary Appendix, Section 1.2).
[b] This sample consists of facilities identified by exact matching on county where the mandate facility was located and nearest neighbor matching on measures of pre-period resident COVID-19 case rates (see Supplementary Appendix, Section 2.2).
[c] Total number of unique staff working in a nursing home each day.
[d] Number of care hours worked by nursing staff per patient.
[e] Reported means are for Certified Nursing Assistants (CNAs) only.

Notes. This table reports means of outcomes and nursing home characteristics followed by the standard deviation. For time varying measures such as health and employment outcomes, the reported means for mandate nursing homes (columns 1 and 3) pertain to the week prior to mandate announcement. Means for the non-mandate nursing homes (columns 2 and 4) are constructed to sample from the same distribution of weeks that the treatment (mandate announcements) occurred in. Data for the percentage of staff vaccinated, employment outcomes, and COVID outcomes are at the week level. Data for nursing home characteristics are at the year level. Data for quality measures and deficiencies are at quarterly level. Matched sample difference is divided by standard deviation of full mandate sample. p value for two sample t-test (two tailed) on the mean difference between matched mandate and non-mandate sample are reported. Significance at 0.05 level.

In the full sample (columns 1 and 2), mandate and non-mandate facilities were broadly similar but had some differences. Mandate facilities serve patient populations that are somewhate whiter and less-urban. They also had slightly fewer beds. Although the quarterly star rating issued by CMS were similar across groups, mandate facilities were cited for more deficiencies in care and received higher (worse) scores from health inspections. This suggests that mandate facilities were not systematically superior on all dimensions of care. Mandate and non-mandate facilities were generally similar along a number of other dimensions indicating poor quality care, with mandate facilities performing slightly worse on some and better on others. Overall, mandate and non-mandate facilities don't show large systematic differences along the aforementioned dimensions relative to the standard deviation in the sample.

Mandate and non-mandate facilities differ more notably, however, along dimensions affecting the evolution of potential outbreaks outbreaks. Mandate facilities had slightly higher rates of pre-mandate staff vaccination, but also had slightly higher rates of pre-mandate staff COVID infections. They also had approximately twice as many weekly COVID cases and deaths among patients immediately prior to the mandate. Likewise, they had higher cases of the most recent 2 and 10 week periods, as well as showed more recent growth in cases. Together, these statistics imply that mandate facilities were facing different epidemiological trajectories immediately prior to the mandate. Specifically, they were more likely to have recent and growing case rates compared to non-mandate facilities.

The possibility that mandate and non-mandate facilities could have been slated to follow different epidemiological trajectories even absent the mandate underlies the decision to use a matched control sample when analyzing COVID outcomes. Columns (3) and (4) present summary statistics for the matched sample. As expected given the matching criteria used, the treatment and control facilities are quite similar on COVID-related outcomes. However, it is noteworthy that the treatment facilities in the matched sample are generally more COVID-naive than the treated units in the full sample. This reflects that for treated facilities experiencing a recent or ongoing COVID outbreak, it is difficult to identify a control facility in the same county following a sufficiently similar epidemiological trajectory. As a result, our matched sample primarily consists of facilities without large recent or ongoing outbreaks. This does not invalidate our estimates, however it does slightly alter their interpretation. In particular, our estimates in the matched sample should be interpreted as the treatment effect of a mandate for a facility not actively in a major outbreak.

Other differences across the mandate and non-mandate facilities—which were already small relative to the standard deviation in the full sample—generally remained small. However, the urban, race, income, and payer gaps do slightly widen. Interestingly, the household incomes where both treated and control units in the matched sample are located are much higher than in the full sample. The matched controls are particularly high, implying that the non-mandate facilities that are most similar to mandate facilities in terms of COVID transmission serve richer patients than the average non-mandate facility in the full sample.

It's important to emphasize that any imperfect matching along non-epidemiological dimensions are likely to be well-address by fixed effects in the difference-in-difference and are therefore not a major concern for our empirical exercise. In contrast, it is quite comforting that our matched sample restricts to mandate and non-mandate facilities that exhibit similar recent outbreak trends, as poor matching along these dimensions could affect the plausibility of the parallel trends assumption when examining COVID-related outcomes.

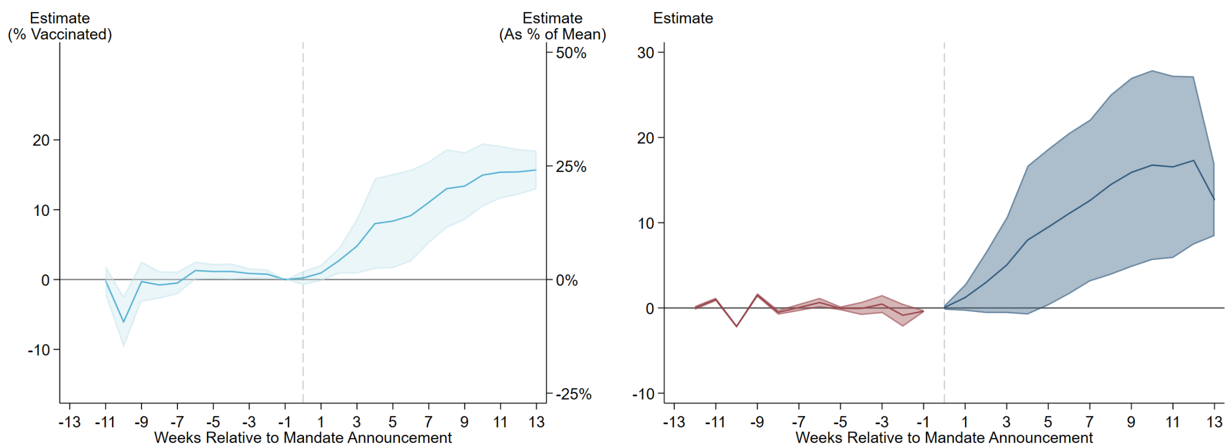
B Additional Results

B.1 Sensitivity Analyses

Figure B8: Estimated Effect of Mandate Announcement on Staff Vaccination Rates

Staff Size

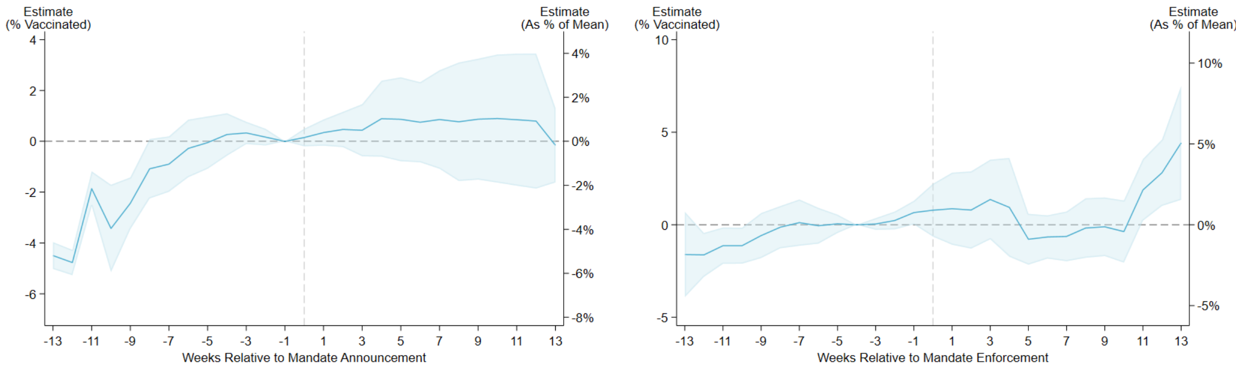
(a) Matched sample **(b) CSDID**



Notes. These figures plot event study regression estimates comparing treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include facility and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline one week prior to mandate announcement. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side of panels (a) represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

Figure B9: Estimated Effect of Mandate Announcement on Resident Vaccination Rates

(a) Mandate Announcement **(b) Mandate Enforcement**

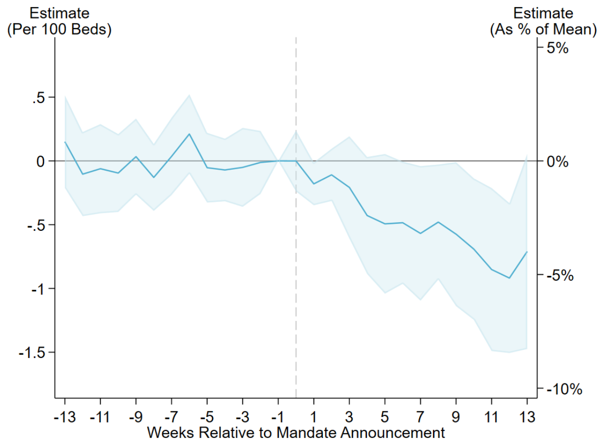


Notes. These figures plot event study regression estimates comparing treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include facility and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline one week prior to mandate announcement. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side of panels (a) represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

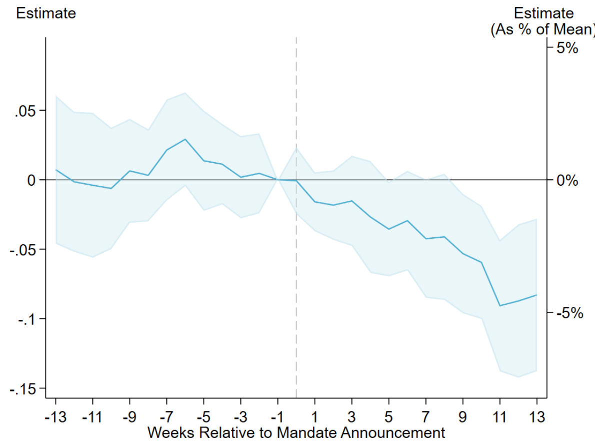
Figure B10: Estimated Effect of Mandate Announcement on Staffing Levels

Matched Sample

(a) Staff Size

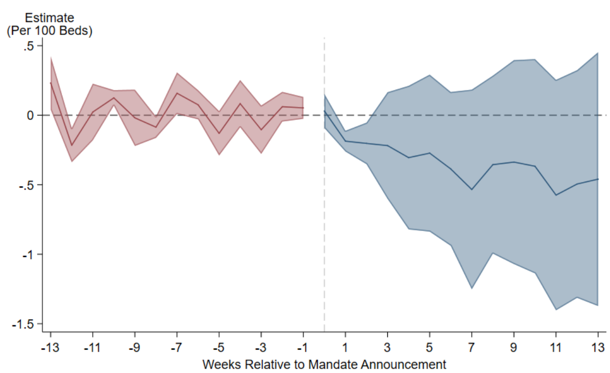


(b) Hour Per Patient Day

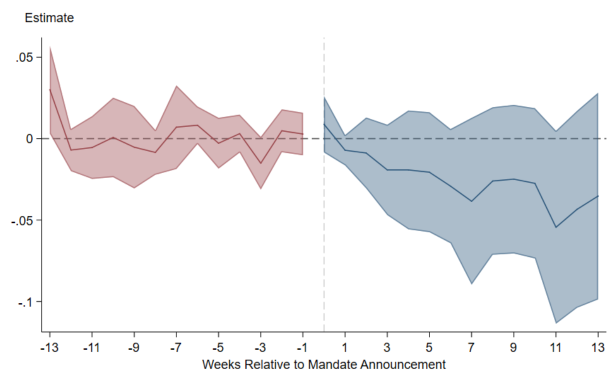


CSDID

(c) Staff Size



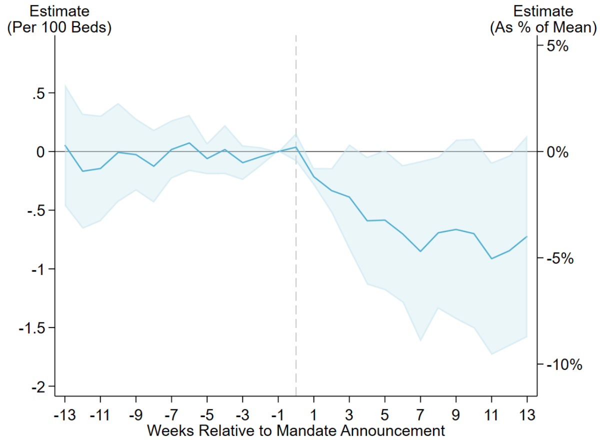
(d) Hour Per Patient Day



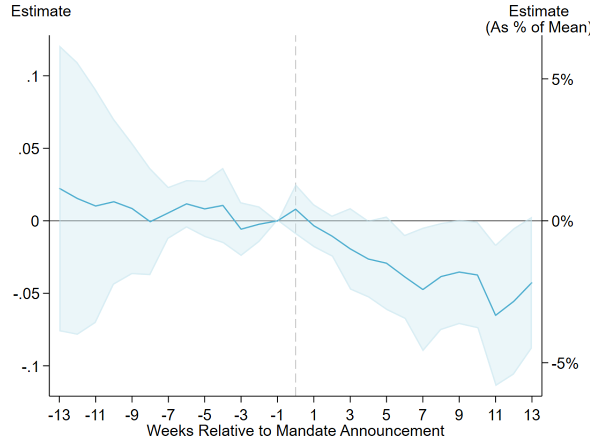
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

Figure B11: Estimated Effect of Mandate Announcement on Staffing Levels Among Chain Facilities Only

(a) Staff Size



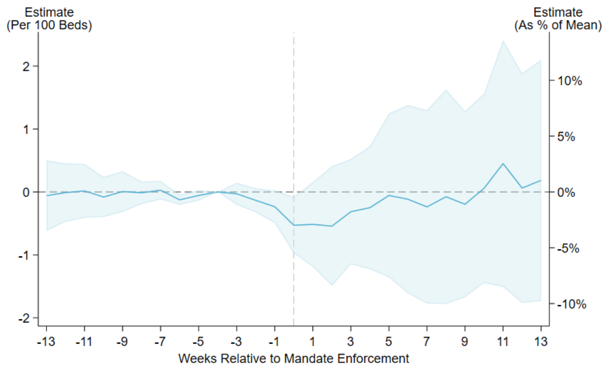
(b) Hour Per Patient Day



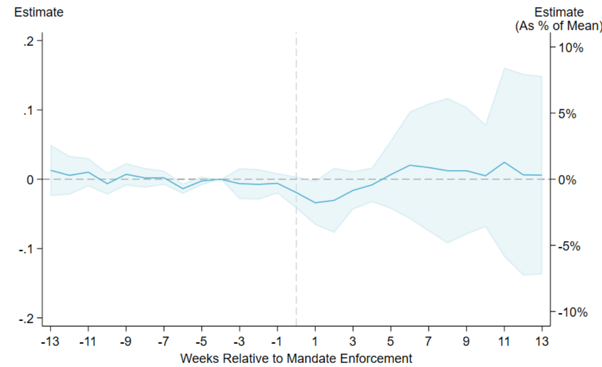
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

Figure B12: Estimated Effect of Mandate Enforcement on CNA Staffing Levels

(a) Staff Size



(b) Hour Per Patient Day

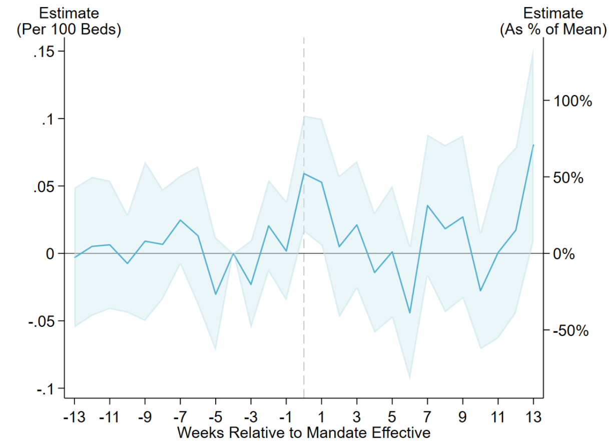


Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were enforced. Four weeks prior to the mandate effective week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side represents the estimate as percent change relative to the four weeks prior to the mandate enforcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

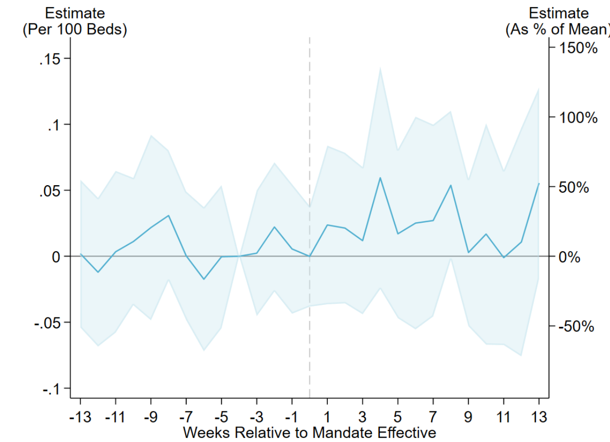
Figure B13: Estimated Effect of Mandate Enforcement on CNA Staffing Changes

Matched Sample

(a) Separations

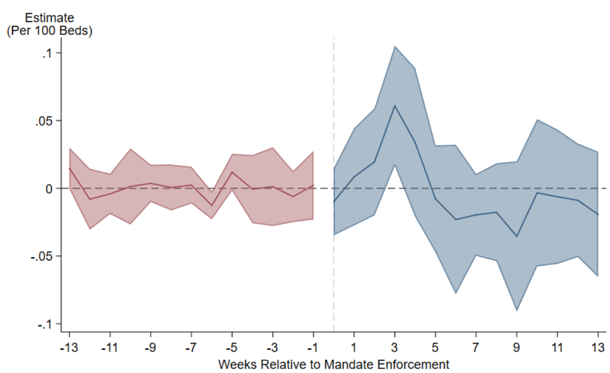


(b) Hires

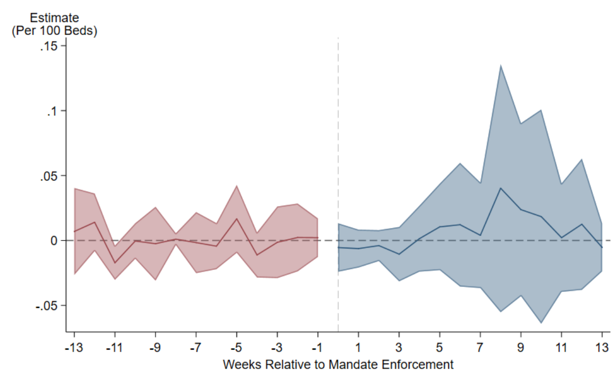


CSDID

(c) Separations



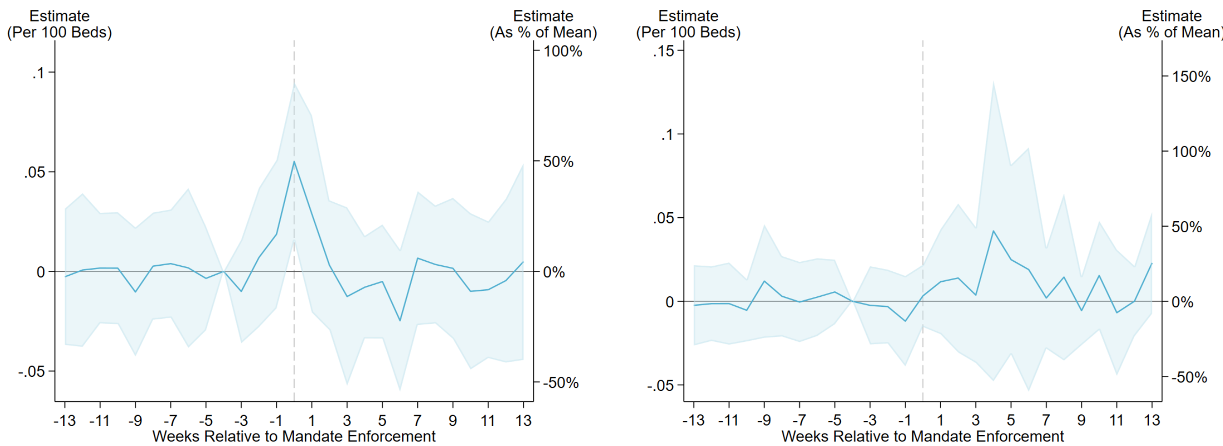
(d) Hires



Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were in effect. Four weeks prior to the mandate effective week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side in panels (a) and (c) represents the estimate as percent change relative to the four weeks prior to the mandate enforcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

Figure B14: Estimated Effect of Mandate Enforcement on CNA Staffing Changes Among Chain Facilities Only

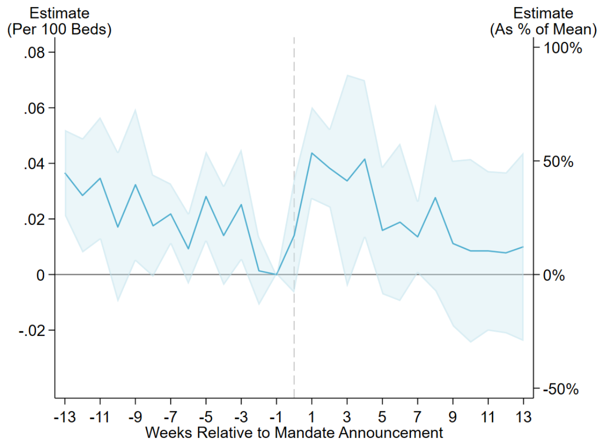
(a) Separations **(b) Hires**



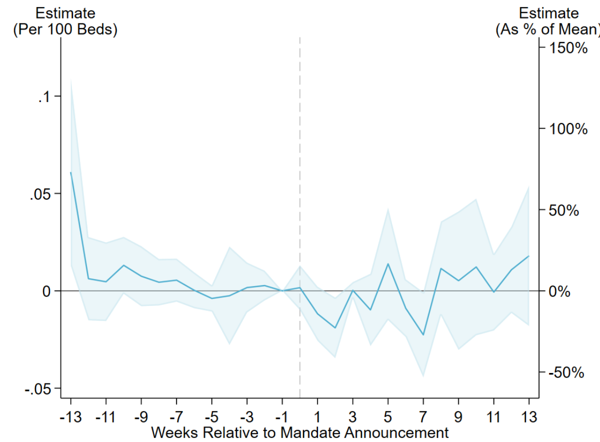
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were in effect. Four weeks prior to the mandate enforcement week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side in panels (a) and (c) represents the estimate as percent change relative to the four weeks prior to the mandate effective week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

Figure B15: Estimated Effect of Mandate Announcement on CNA Staffing Changes

(a) Separations



(b) Hires



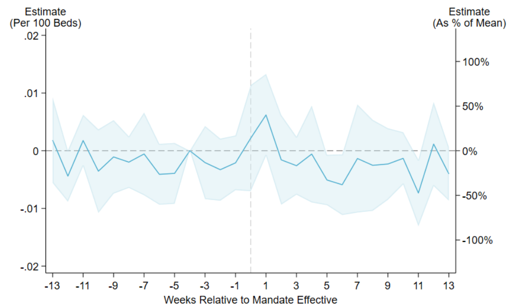
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

B.2 Results for CNA Subgroups

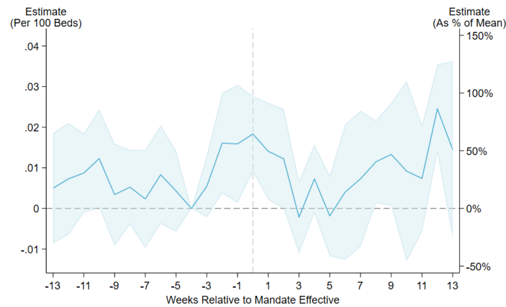
Figure B16: Estimated Effect of Mandate Enforcement on CNA Staffing Changes

Separations

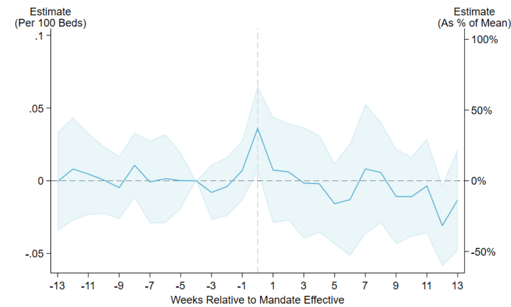
(a) Full-time Staff



(b) Part-time Staff

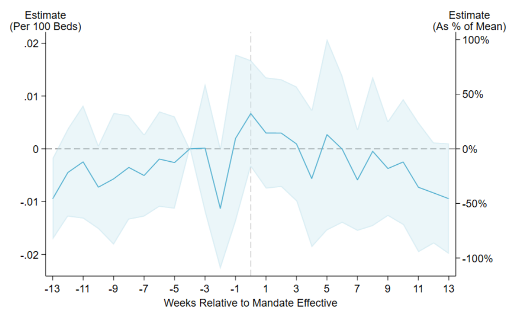


(c) Very Part-time Staff

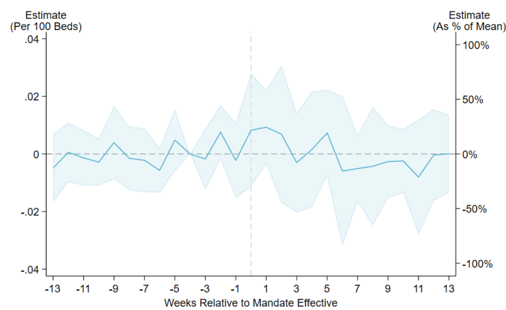


New Hires

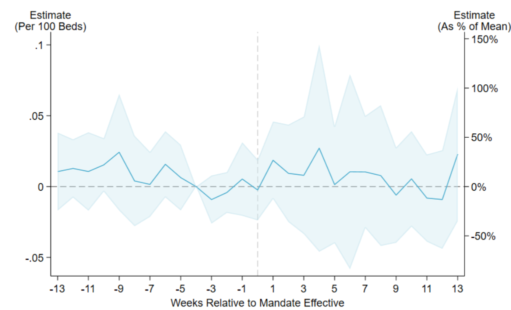
(d) Full-time Staff



(e) Part-time Staff



(f) Very Part-time Staff



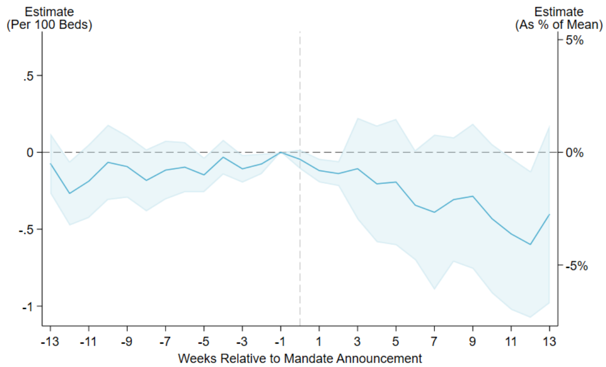
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were in effect. Four weeks prior to the mandate effective week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side represents the estimate as percent change relative to the four weeks prior to the mandate becoming enfroced. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

B.2.1 Results for CNAs by Length of Employment

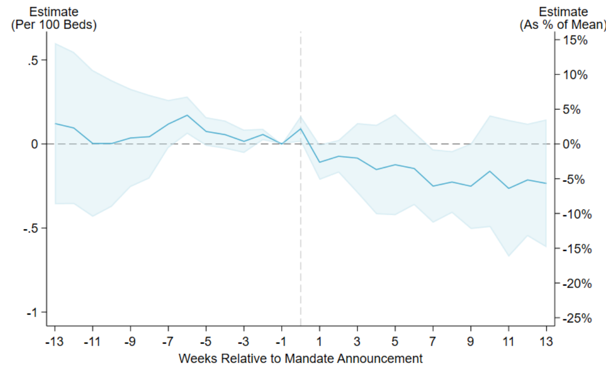
Figure B17: Estimated Effect of Mandate Announcement on CNA Staffing Levels

Staff Size

(a) ≥500 hours

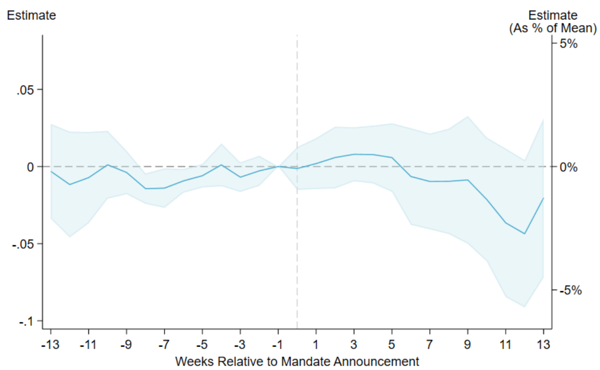


(b) <500 hours

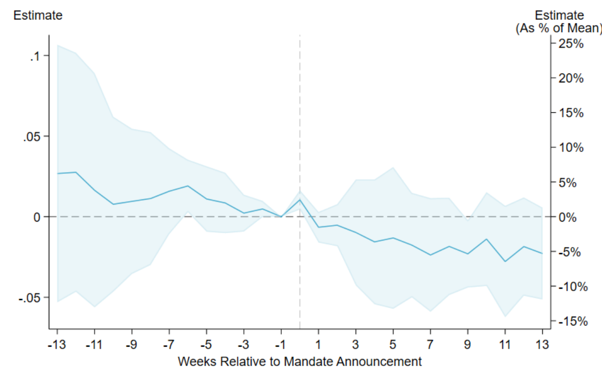


Hours Per Resident Day

(c) ≥500 hours



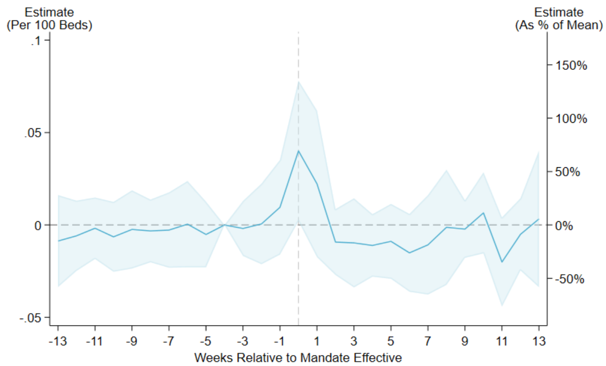
(d) <500 hours

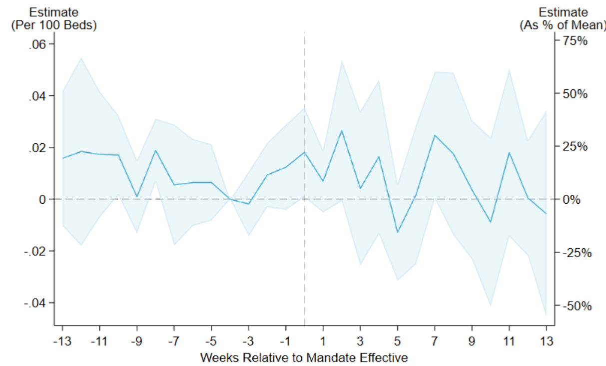


Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced. The y-axis on the right-hand side of panels (a) represents the estimate as percent change relative to the week prior to the mandate announcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced.

Figure B18: Estimated Effect of Mandate Enforcement on CNA Staffing Changes

Staff Size





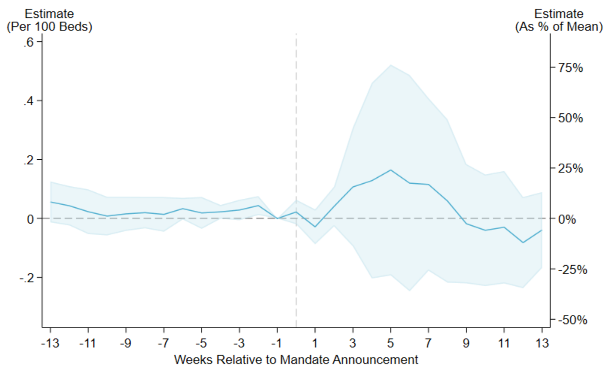
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were in effect. Four weeks prior to the mandate enforcement week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side represents the estimate as percent change relative to the four weeks prior to the mandate becoming enforced. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

B.2.2 Results for CNA Contract Workers

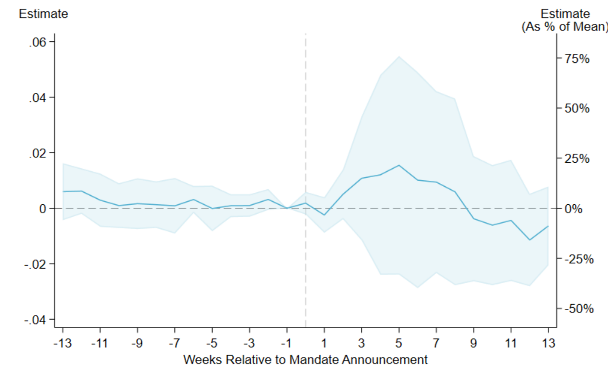
Figure B19: Estimated Effect of Mandates on CNA Contract Workers

Staffing Levels

(a) Staff Size

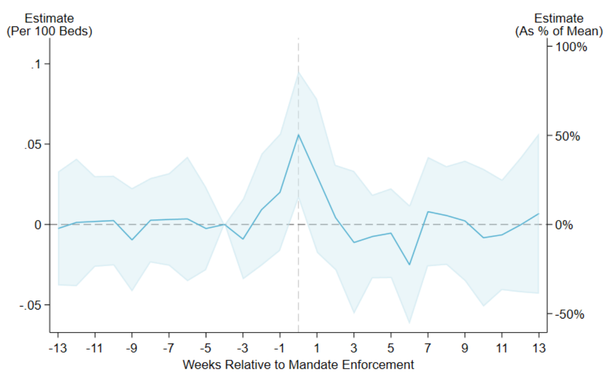


(b) Hours Per Resident Day

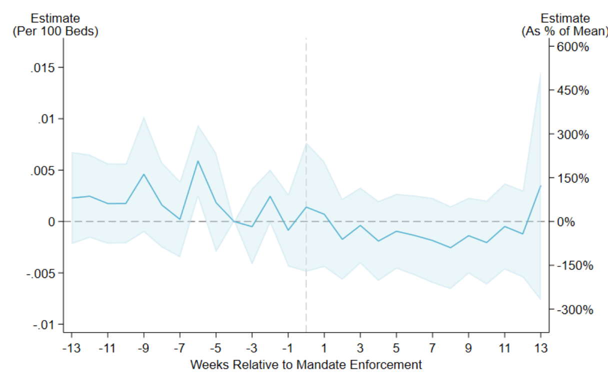


Staffing Changes

(c) Separations



(d) Hires



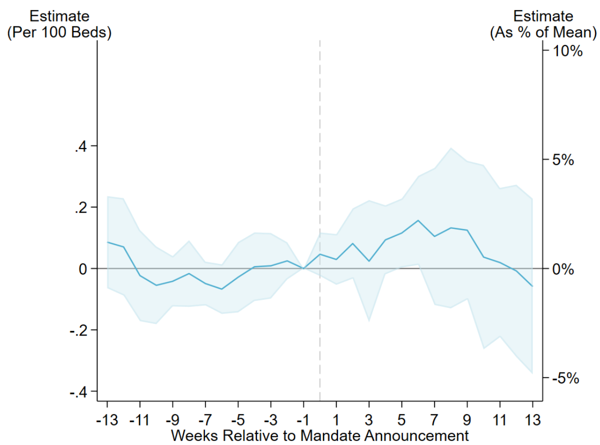
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced for panels (a) and (b). The y-axis on the left-hand side shows the change for each outcome relative to four weeks prior to the week when vaccination mandates were in effect for panels (c) and (d). Four weeks prior to the mandate enforcement week is used as the reference period because of potential anticipation effects.The y-axis on the right-hand side of panels (a) and (b) represents the estimate as percent change relative to the week prior to the mandate announcement week. The y-axis on the right-hand side of panels (c) and (d) represents the estimate as percent change relative to the four weeks prior to the mandate becoming enforced. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was announced (or enforced).

B.3 Results for Licensed Practical Nurses (LPNs)

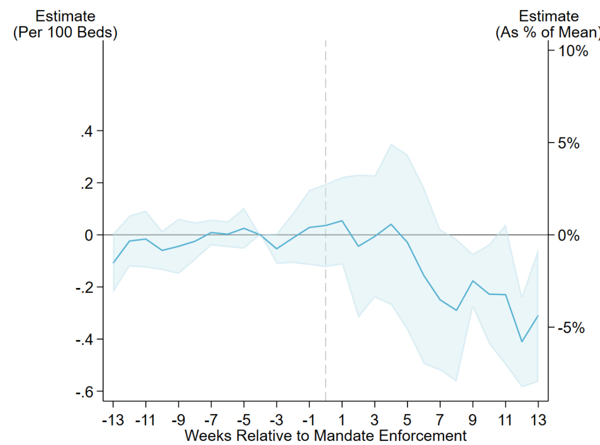
Figure B20: Estimated Effect of Mandates on LPN Staffing Levels

Staff Size

(a) Mandate Announcement

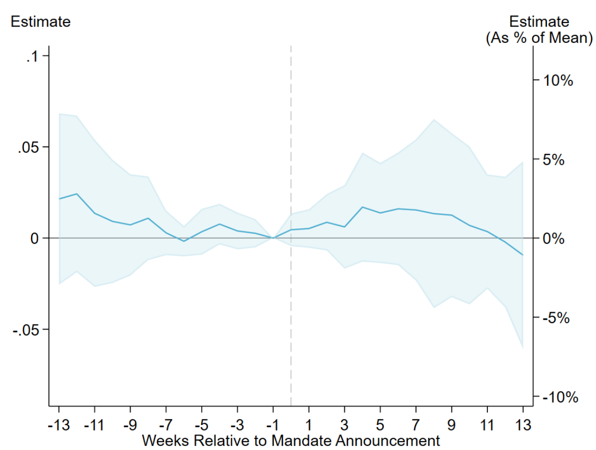


(b) Mandate Enforcement

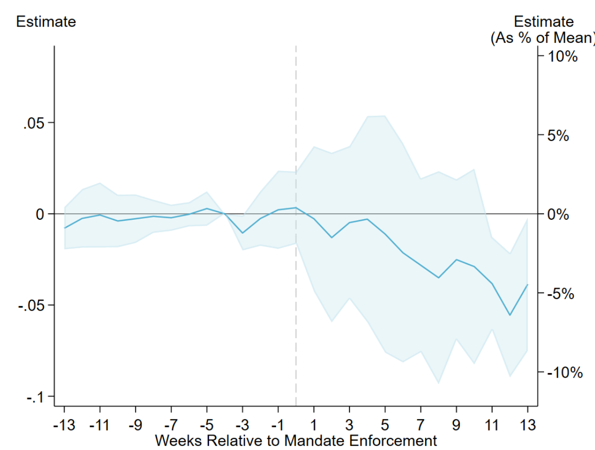


Hour Per Patient Day

(c) Mandate Announcement



(d) Mandate Enforcement

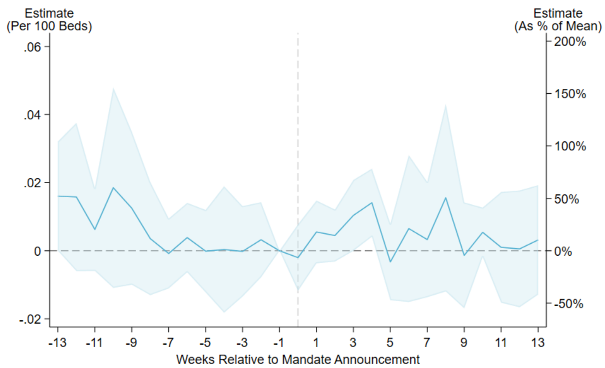


Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced in panels (a) and (c) and relative to four weeks prior to the week when vaccination mandates were enforced in panels (b) and (d). Four weeks prior to the mandate effective week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The y-axis on the right-hand side of panels (b) and (d) represents the estimate as percent change relative to the four weeks prior to the mandate enforcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

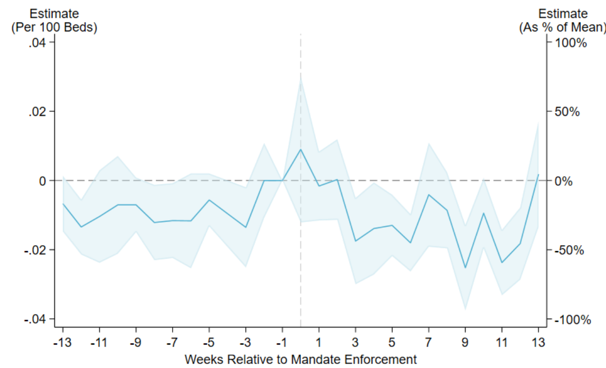
Figure B21: Estimated Effect of Mandates on LPN Staffing Changes

Separations

(a) Mandate Announcement

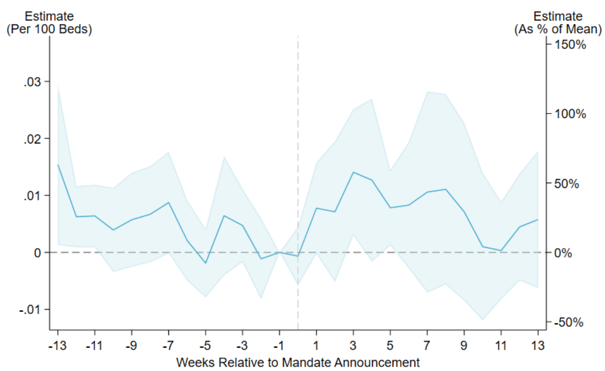


(b) Mandate Enforcement

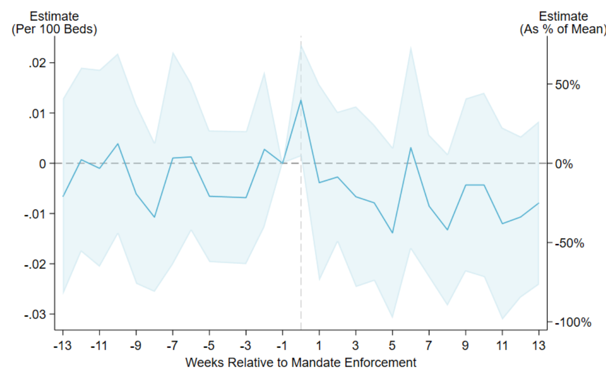


Hires

(c) Mandate Announcement



(d) Mandate Enforcement



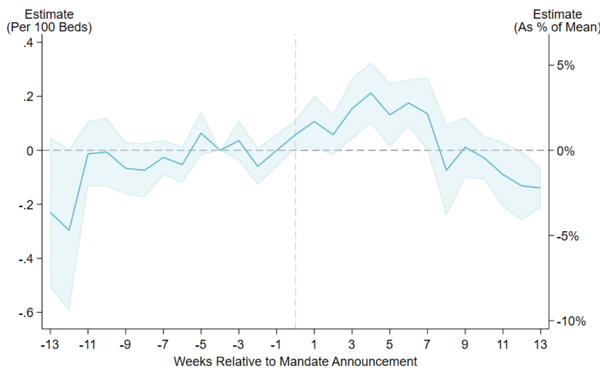
Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced in panels (a) and (c) and relative to four weeks prior to the week when vaccination mandates were enforced in panels (b) and (d). Four weeks prior to the mandate enforcement week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The y-axis on the right-hand side of panels (b) and (d) represents the estimate as percent change relative to the four weeks prior to the mandate effective week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

B.4 Results for Registered Nurses (RNs)

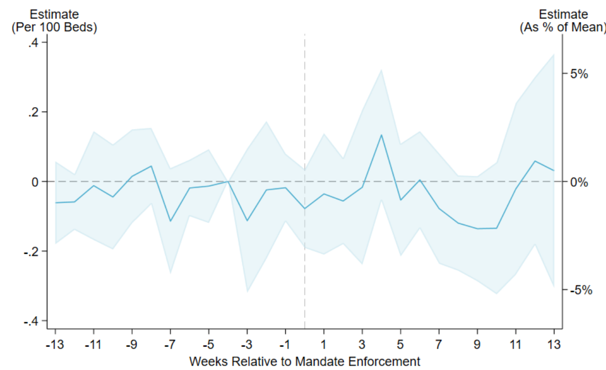
Figure B22: Estimated Effect of Mandates on RN Staffing Levels

Staff Size

(a) Mandate Announcement

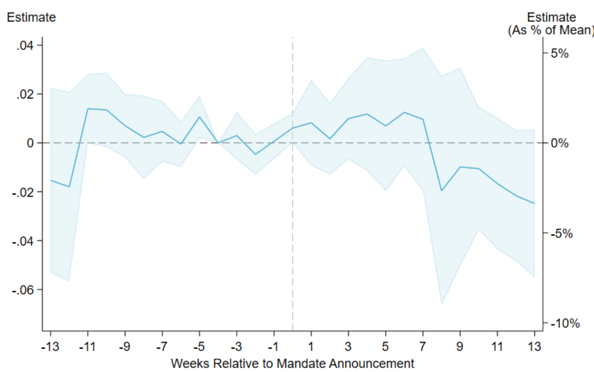


(b) Mandate Enforcement

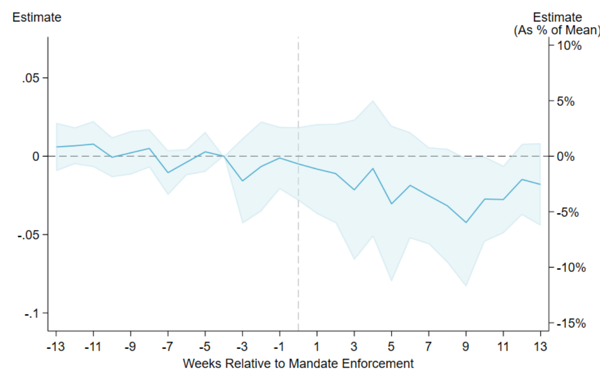


Hour Per Patient Day

(c) Mandate Announcement



(d) Mandate Enforcement

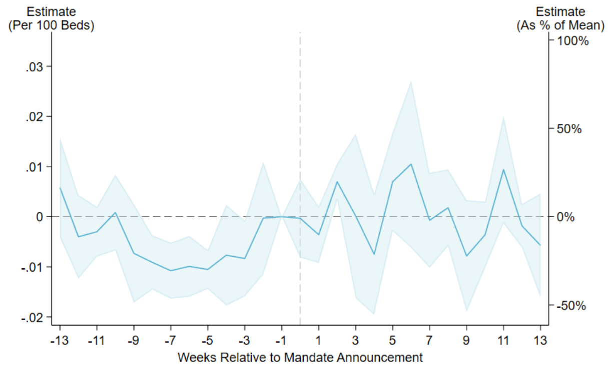


Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced in panels (a) and (c) and relative to four weeks prior to the week when vaccination mandates were enforced in panels (b) and (d). Four weeks prior to the mandate enforced week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The y-axis on the right-hand side of panels (b) and (d) represents the estimate as percent change relative to the four weeks prior to the mandate enforcement week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

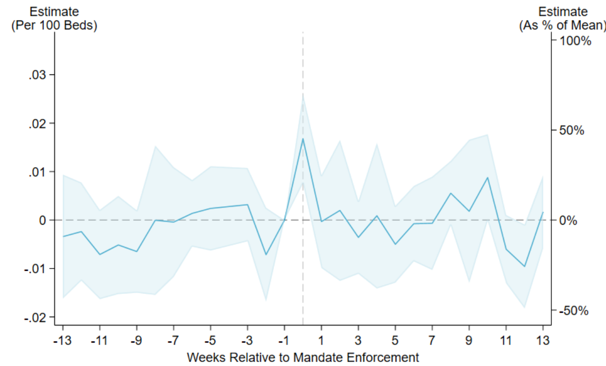
Figure B23: Estimated Effect of Mandates on RN Staffing Changes

Separations

(a) Mandate Announcement



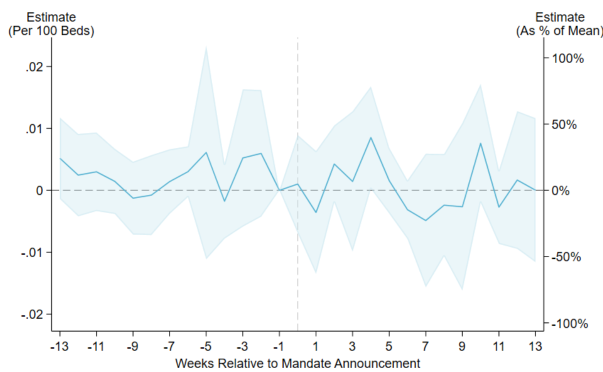
(b) Mandate Enforcement

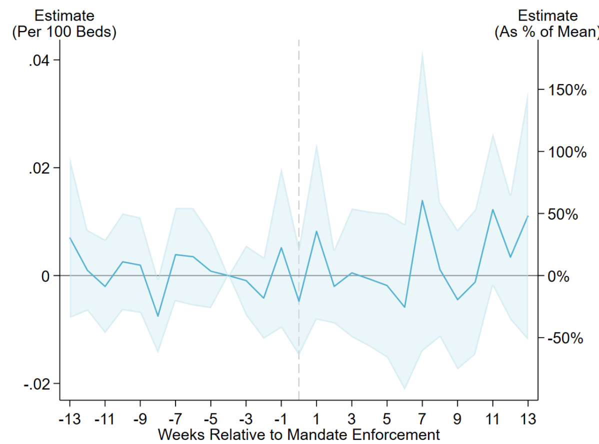


Hires

(d) Mandate Enforcement

(c) Mandate Announcement



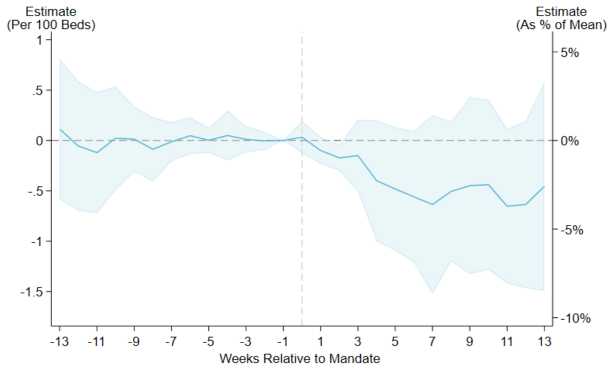


Notes. These figures plot event study regressions which compare treated facilities that implemented a vaccination mandate relative to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis on the left-hand side shows the change for each outcome relative to to the week when vaccination mandates were announced in panels (a) and (c) and relative to four weeks prior to the week when vaccination mandates were enforced in panels (b) and (d). Four weeks prior to the mandate enforcement week is used as the reference period because of potential anticipation effects. The y-axis on the right-hand side of panels (a) and (c) represents the estimate as percent change relative to the week prior to the mandate announcement week. The y-axis on the right-hand side of panels (b) and (d) represents the estimate as percent change relative to the four weeks prior to the mandate effective week. The x-axis illustrates the event-time relative to the week in which the chain's vaccination mandate was enforced.

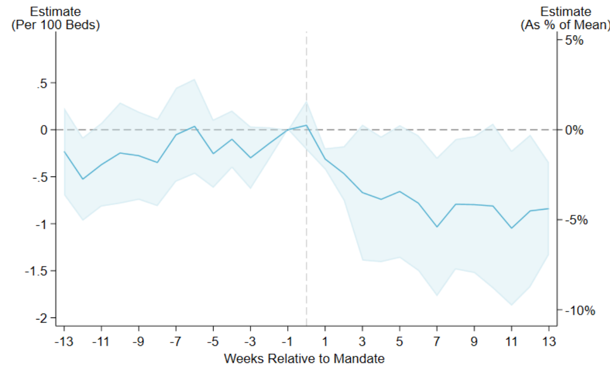
B.5 Analysis by Level of Market Concentration

Figure B24: Estimated Effect of Mandate Announcement on CNA Staff Size by Market Concentration

(a) HHI < 0.15



(b) HHI >= 0.15

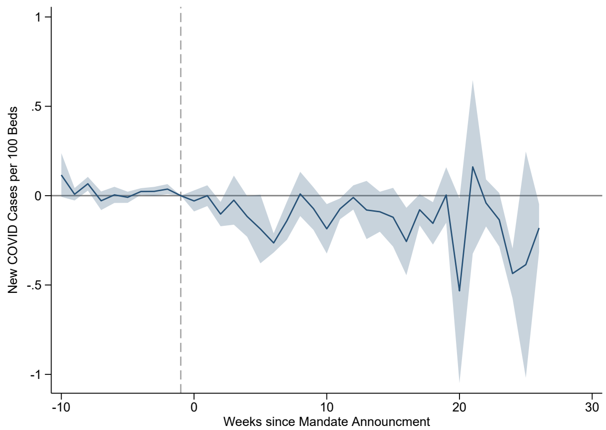


Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.

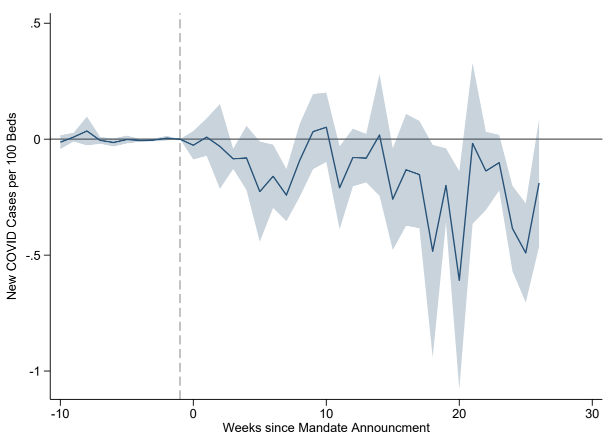
B.6 Results for COVID Cases and Deaths

Figure B25: Event Study for COVID Cases and Deaths (Weekly Estimates; Matched Sample)

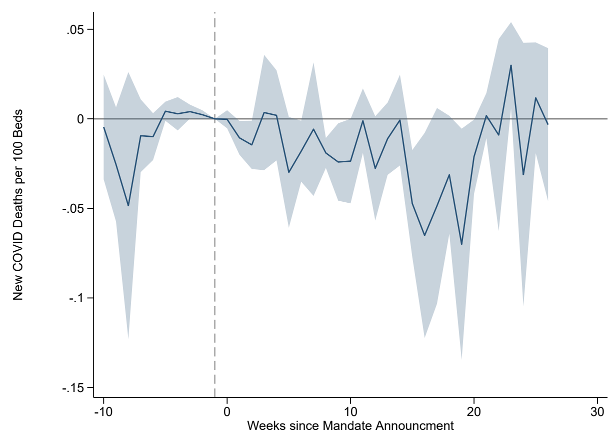
(a) Staff Cases



(b) Resident Cases



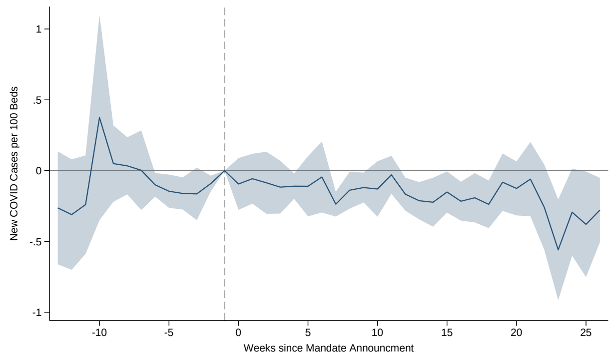
(c) Resident Deaths



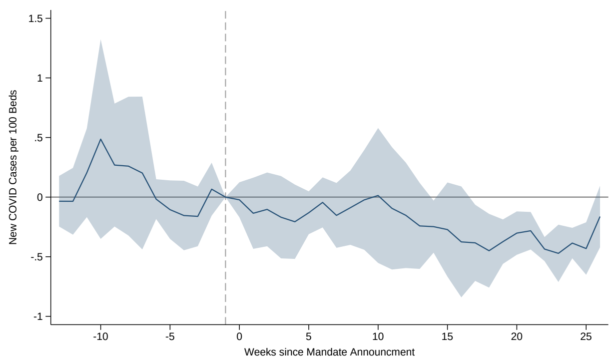
Notes. These figures plot matched stacked event study estimates which compare matched treated facilities that implemented a vaccination mandate to matched control facilities that did not implement a vaccination mandate. Regressions include week and facility-by-cohort fixed effects and controls for resident vaccination rates. Standard errors are clustered at the chain level. The y-axis represents weekly staff COVID cases (a), resident COVID cases (b), and resident COVID deaths (c) per 100 beds. Estimates for weeks >=0 are summed to calculate the cumulative effect estimates presented in Figure 2 in the manuscript.

Figure B26: Event Study for COVID Cases and Deaths (Weekly Estimates; Unmatched Sample)

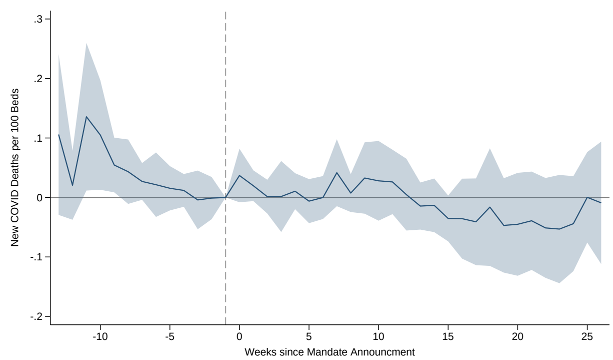
(a) Staff Cases



(b) Resident Cases



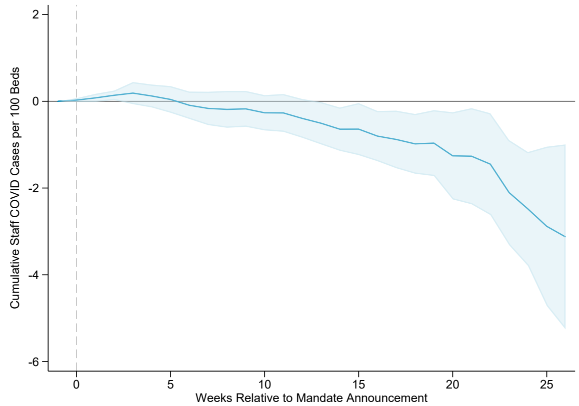
(c) Resident Deaths



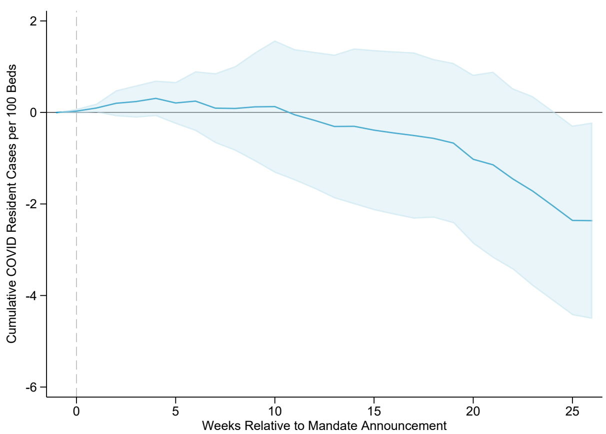
Notes. These figures plot weekly event study estimates which compare treated facilities that implemented a vaccination mandate to control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects and controls for resident vaccination rates. Standard errors are clustered at the chain level. The y-axis represents weekly staff COVID cases (a), resident COVID cases (b), and resident COVID deaths (c) per 100 beds.

Figure B27: Event Study for COVID Cases and Deaths (CSDID)

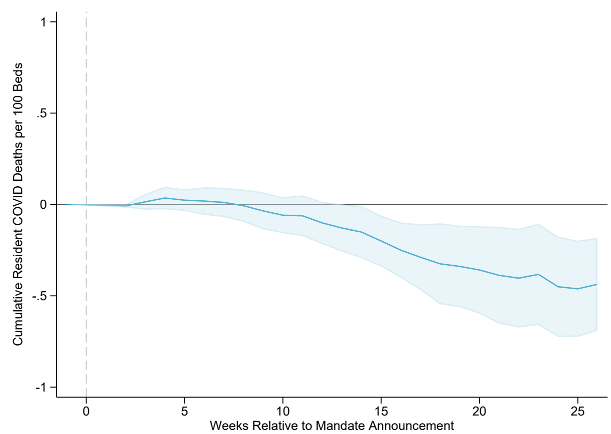
(a) Staff Cases



(b) Resident Cases



(c) Resident Deaths

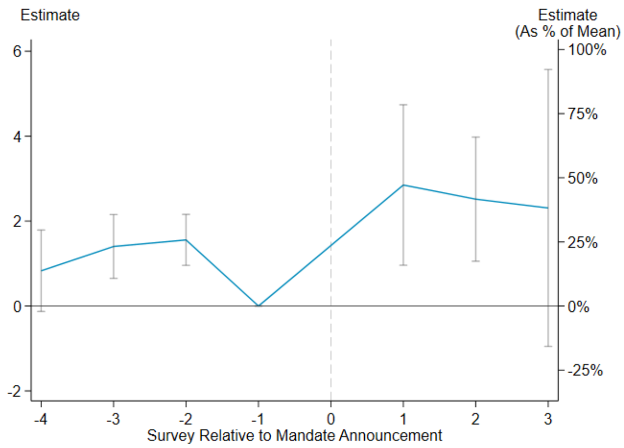


Notes. These figures plot matched event study estimates which compare matched treated facilities that implemented a vaccination mandate relative to matched control facilities that did not implement a vaccination mandate. Regressions include week and facility fixed effects. Standard errors are clustered at the chain level. The y-axis represents weekly cumulative staff COVID cases (a), resident COVID cases (b), and resident COVID deaths (c) per 100 beds. Estimates were obtained using the Callaway-Sant'Anna difference-in-differences estimation packed to account for potential negative weighting bias.

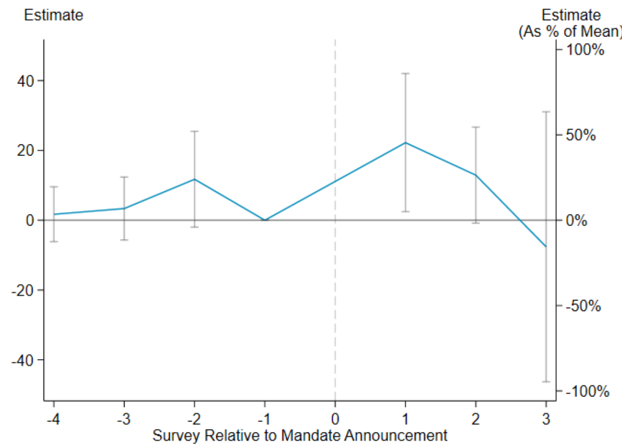
B.7 Effects of Mandates on Quality Measures and Health Inspections

Figure B28: Estimated Effect of Mandate Announcement on Health Inspections

(a) Count of Deficiencies



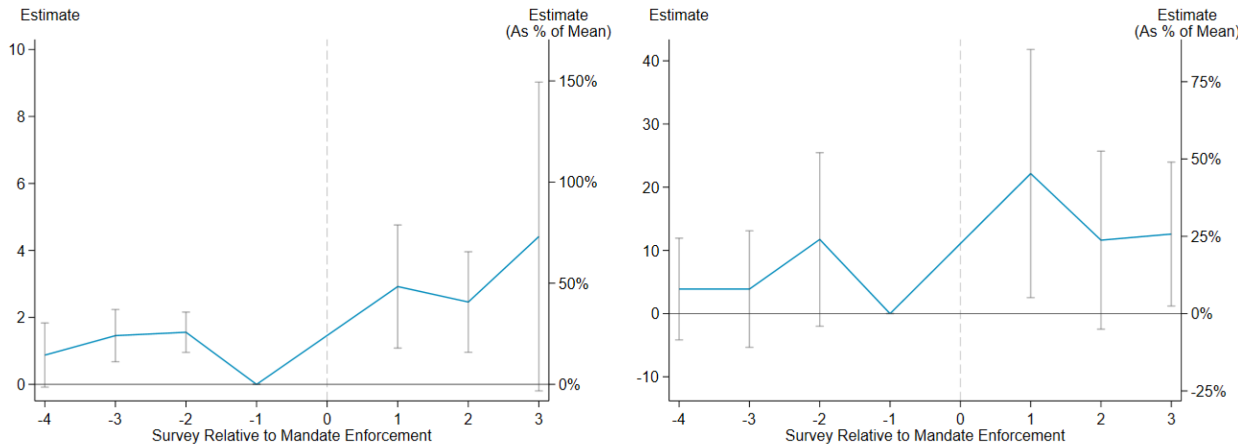
(b) Total Score



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate, using data from Nursing Home Compare. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.

Figure B29: Estimated Effect of Mandate Enforcement on Health Inspections

(a) Count of Deficiencies **(b) Total Score**

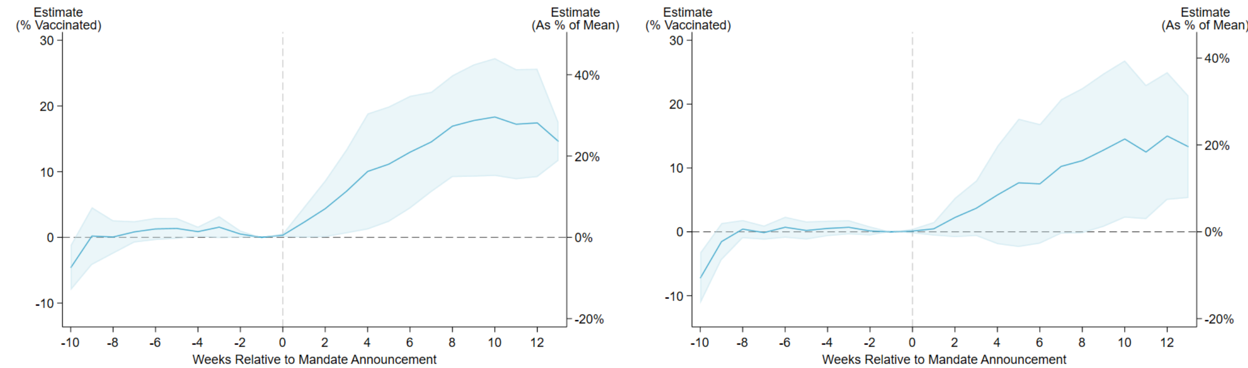


Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate, using data from Nursing Home Compare. Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates are computed relative to a baseline week that is 4 weeks prior to the mandate becoming enforced. Four weeks was the authorized interval between first and second dose for the Moderna vaccine. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.

Figure B30: Estimated Effect of Mandates on Staff Vaccination Rates by Provider Quality

Staff Size

(a) Low Quality **(b) High Quality**

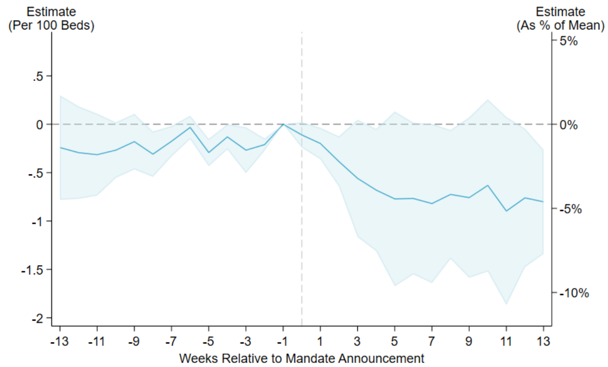


Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate, using data from Nursing Home Compare. The median star rating score was 3. "Low quality" nursing homes are those that received a star rating of 1 or 2, while "high-quality" nursing homes are those that received a star rating of 4 or 5 Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.

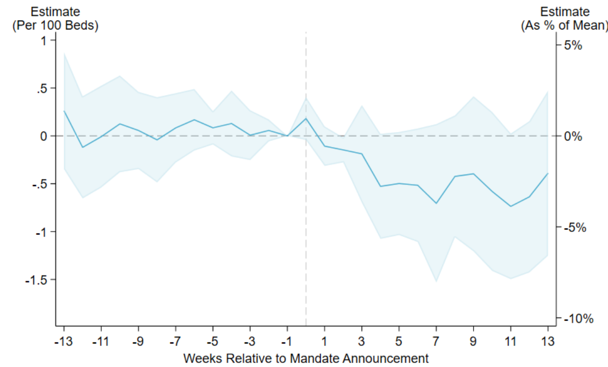
Figure B31: Estimated Effect of Mandates on CNA Staffing Levels by Provider Quality

Staff Size

(a) Low Quality

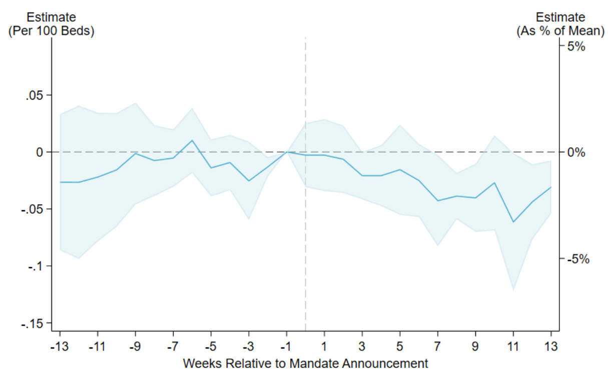


(b) High Quality

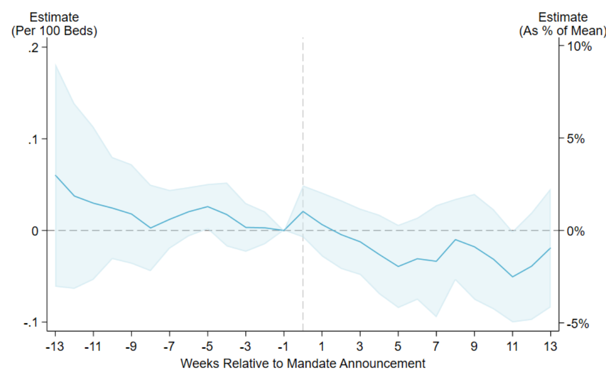


Hours Per Patient Day

(c) Low Quality



(d) High Quality

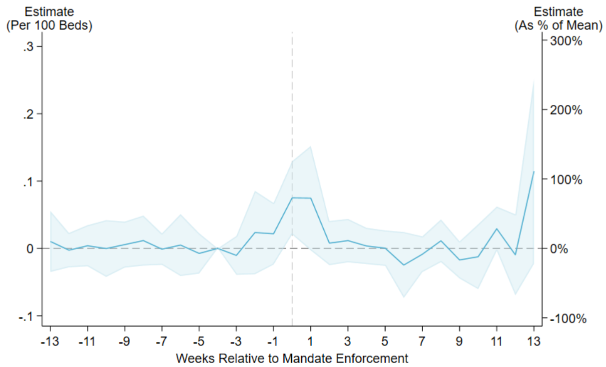


Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate, using data from Nursing Home Compare. The median star rating score was 3. "Low quality" nursing homes are those that received a star rating of 1 or 2, while "high-quality" nursing homes are those that received a star rating of 4 or 5 Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.

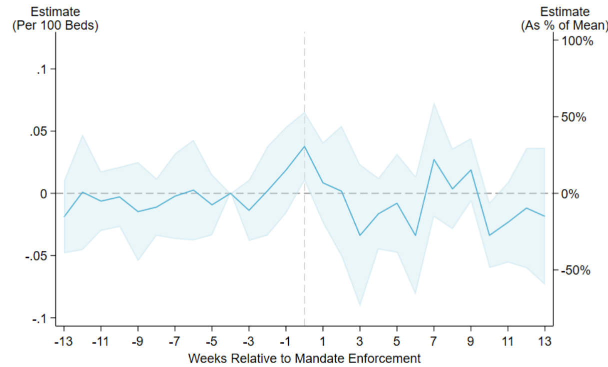
Figure B32: Estimated Effect of Mandates on CNA Staffing Changes by Provider Quality

Separations

(a) Low Quality

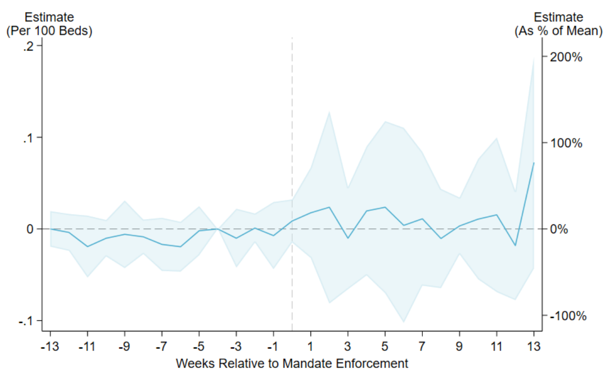


(b) High Quality

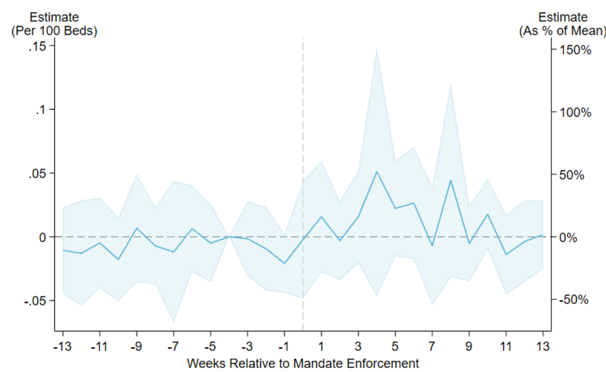


New Hires

(c) Low Quality



(d) High Quality



Notes. These figures plot event study regression estimates comparing treated nursing homes that implemented a vaccination mandate relative to control nursing homes that did not implement a vaccination mandate, using data from Nursing Home Compare. The median star rating score was 3. "Low quality" nursing homes are those that received a star rating of 1 or 2, while "high-quality" nursing homes are those that received a star rating of 4 or 5 Regressions include nursing home and week fixed effects. Standard errors are clustered at the chain level. Estimates in are computed relative to a baseline one week prior to mandate announcement. The left axes present the estimates, and the right axes present the estimates scaled by the mean of the outcome variable for treated nursing homes in the baseline week.