

## Supplemental Online Content

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**eMethods 1.** Supplementary Detail on Data Sources and Sample

**eMethods 2.** Supplementary Details on Methods

**eReferences**

This supplemental material has been provided by the authors to give readers additional information about their work.

## **eMethods 1. Supplementary Detail on Data Sources and Sample**

The primary data source for this study was the Centers for Medicare and Medicaid Services (CMS) COVID-19 Nursing Home Data database. These publicly available data provide information submitted, on a weekly basis, by skilled nursing facilities (SNFs) to the CDC's National Healthcare Safety Network Long-term Care Facility COVID-19 Module.<sup>1</sup> Facilities are federally mandated to submit this weekly data. Reporting rates to the NHSN are consistently high (e.g., 14,910 of the 15,302 (97.4%) U.S. nursing homes reported data during the week ending July 18, 2021).

In May of 2021, CMS began requiring nursing homes to report resident and staff vaccination coverages on a weekly basis. For residents, facilities must report: 1) the number of residents who stayed at least 24 hours in the nursing home during the week of data collection and 2) the cumulative number of residents who received partial or completed doses of an authorized COVID-19 vaccination. Partial doses refer to one shot of the Moderna and Pfizer-BioNTech vaccines; completed doses refer to two shots of the Moderna and Pfizer-BioNTech vaccines or one dose of Janssen. For staff, facilities report: 1) the number of staff who were eligible to work at least a portion of 1 day during the week of data collection (including staff who are on temporary (i.e., leave that is  $\leq 2$  weeks) and 2) the number of staff with completed or partial courses of a COVID-19 vaccine.<sup>2</sup> Nursing homes also report staff counts and vaccination doses for select types of workers, including nurses, nursing assistant, physicians and independent practitioners, therapists, and ancillary staff. To date, not all facilities are reporting vaccination data for these specific staff types. Importantly, vaccines were widely available by June 2021, and nursing home staff members' access to COVID-19 vaccines was prioritized by state and federal programs. Therefore, measured vaccination coverages are unlikely to reflect vaccine shortages.

Because these data are new, we performed a series of quality checks to ensure that reported vaccination values are reasonable, including confirming that vaccinations do not exceed the reported number of staff and/or residents, that resident counts are plausible given a nursing home's bed size, and that staff size is consistent with values previously reported in payroll-based journal staffing data. In some cases, it appears that nursing homes report 0 completed vaccine doses for staff as a stand-in for missing or unknown. See below for details on how such instances were handled.

### *Additional Data Sources*

We obtained information about nursing homes, including overall quality ratings, profit status, and bed size from the 2021 Nursing Home Compare Provider Information dataset.<sup>3</sup> Additional information about nursing homes, including the racial/ethnic composition of residents, the share of residents with Medicaid, and chain affiliation were obtained from the 2017 Certification and Survey Provider Enhancement Reports (CASPER) system and 2017 Minimum Data Set (MDS) assessments, both through the National Institute on Aging-funded LTCFocus.org website.<sup>4</sup> Staff information was obtained from individuals-level staffing records submitted by nursing homes during the fourth quarter of 2020 as part of CMS's mandatory payroll-based journal (PBJ) electronic staffing reporting system.<sup>5,6</sup>

Nursing home staff demographics, including age, gender, and race/ethnicity, are estimated by matching nursing homes to the 2018 Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics (LODES) data from the U.S. Census Bureau. These data are primarily derived from state administrative records (e.g. unemployment insurance records), and commonly used to study commuting patterns. We use the Workplace Area Characteristics (WAC) file to obtain measures of staff racial breakdowns, and the Origin-Destination (OD) file to obtain staff neighborhood characteristics (e.g., the average of tract median income across each facility's staff neighborhoods). These data are provided at the workplace census block level. To match each facility to the corresponding census block, we first used the Census Geocoder and the Google Maps API to obtain a matched census block to the facility address from Nursing Home Compare. We then use the WAC file to check that this census block contains a reasonable number of employees in the health care and social assistance sector. To do this, we kept blocks where the number of employees in the health care and social assistance sector was more than half of the number of unique employees in 2018Q1. For the facility-block combinations that

did not meet this condition (17% of the sample), we search for a block that meets this condition in the same block group, and take the closest block that meets this condition to be the nursing home's census block. This recovers 70% of the dropped facilities.

We obtained county-level measures of adult (i.e., age 18 and older) vaccination coverage through July 19, 2021 via the CDC's Vaccine Hesitancy survey and its COVID-19 Vaccinations database and 2020 election results from a number of publicly available media outlets.<sup>7-9</sup>

### **Sample Construction**

At the time of this study, weekly vaccination data was collected for the weeks ending May 30, 2021 through July 18, 2021. For each nursing home, we select the most recently available week of data where both the number of completed vaccines and the relevant population size was reported for the following categories: 1) residents, 2) all healthcare personnel, 3) CNAs, 4) nurses, 5) therapists, 6) physicians and other licensed and independent practitioners. For overall healthcare staff and resident vaccination rates, over 98% of reporting facilities had data available for either the weeks ending July 11, 2021 or July 18, 2021. For the specific staff types, over 80% of reporting facilities had data available in these two most recent weeks.

Before calculating facility vaccination coverage, we take several steps to exclude facilities that report vaccine numbers that are likely implausible. First, we exclude from all analyses 135 nursing homes who reported that none of their healthcare staff had been vaccinated. Such an extreme low number is unlikely given vaccination rates in the general adult population. Rather, it is likely that because vaccine reporting is mandatory and subject to penalties, some facilities use 0 to indicate missing or unknown. This practice appears uncommon in the reporting of overall staff and resident vaccination rates, but more common in the specific staff types.

As such, we apply additional restrictions prior to calculating staff-specific vaccine coverage. Namely, we drop an additional 750 facilities that reported no vaccinations for both CNAs and nurses. Finally, we exclude another 25 facilities that reported 0 vaccines for all non-direct care staff categories (therapists, physicians, and ancillary [i.e., non-healthcare]) staff.

### **Variable Construction**

#### *Vaccination Coverage*

Vaccine coverages are calculated by dividing the number of completed vaccines by the reported number of staff eligible to work in the facility in the corresponding week or the number of residents who spent at least part of one day in the nursing home in the corresponding week.

#### *Staffing Measures*

Using the individual-level PBJ data, which identifies each unique employer-employee relationship across a variety of staff types and payment regimes (i.e., contract workers hired through an agency vs. employees paid directly by the nursing home), we constructed a measure of staff size defined as the total number of employees working in the facility in the 4<sup>th</sup> quarter of 2020. Furthermore, for direct care staff (i.e., certified nursing assistants [CNAs], licensed practical nurses [LPNs], and registered nurses [RNs]) we characterize the share of these workers who work under contract (# of contract direct care staff/# of direct care staff), as vaccination dynamics may be different for contract workers that may be more likely to work at multiple facilities. We also quantify the share of the direct care staff that are LPNs (# of LPNs/# of direct care staff) and RNs ((# of RNs/# of direct care staff) to examine potential differences in vaccine uptake between direct care staff types.

Finally, we leverage the individual-level nature of our PBJ staffing data, which assigns a unique ID to each employer-employee relationship, to generate an estimate of staff experience. We first determine the tenure of all direct care staff in the dataset during the period covered by the PBJ data (Quarter 4 of 2016-Q4 of 2020) using the dates of the first and final instances of a unique employer-employee relationship in the data. We estimate the national median tenure across all direct care staff

(in weeks worked, assuming 35 hour work weeks), then, within each facility, we determine the percent of workers in quarter 4 of 2020 who had more experience than the national median (33 weeks).

### *Staff Demographics*

The denominator for our staff demographics measures are all employees who work on the nursing home's matched census block in the "all other services" category. Our main variables of interest are: 1) the share of these workers who are non-white, i.e. do not report their race as being only white (multi-race employees are included in the "non-white" category; Hispanic whites are not included in the "non-white" category), 2) the share of workers who are female, and 3) the share of workers who report their age as less than 29. Importantly, these measures are estimates obtained from 2018 data. As such, they approximate the demographic composition of nursing home staff at that time.

The main potential source of error in these measurements is the inclusion of additional service-sector employees who work on the same block at the nursing home but do not work in the nursing home. For example, if a nursing home shares a block with an assisted living facility, hospital, or other service-sector establishment, those employees will be included in our measures. The median block in our data has 322 service-sector employees, while the median nursing home has 115 unique employees engaged in patient care (note that the latter excludes food service staff or housekeeping staff, because facilities are not required to report hours for these type of staff to the PBJ). To account for this potential source of error, we perform a robustness check where we only use staff demographic variables for blocks where the service sector employment was less than 400% of the PBJ staff count.

### *Nursing Home COVID-19 Burden*

To characterize the impact of the COVID-19 pandemic on each nursing homes, we constructed cumulative measures of the number of staff and resident COVID-19 deaths per 100 beds, as reported in the NHSN data for the period of January 1, 2020 – July 11, 2021.

### *County Election Results*

The 2020 presidential election results were operationalized as the difference between the percent of votes cast for Donald Trump minus the percent of votes cast for Joe Biden within each county. This approach captured county-level voter preferences for the Republican vs. Democratic presidential candidate, ignoring between-county variation in preferences for third-party candidates.

## **eMethods 2. Supplementary Details on Methods**

We calculated weighted median and mean vaccination coverages using the size of the relevant population reported by each nursing home. That is, each facility-level vaccination rate is weighted by the size of the relevant population, so that medians and means reflect individuals (i.e., resident or staff) level estimates of vaccine coverage.

To examine the independent relationship between nursing home characteristics and staff vaccine coverage, we estimated a linear regression model of the following form.

$$Y_{i,c} = \beta_0 + \beta_1 X_{i,c} + \beta_2 Z_c + \gamma + \varepsilon_{i,c} \quad \text{Eq. 1}$$

$Y_{i,c}$  represents the staff or resident vaccination coverage for facility  $i$  located in county  $c$ .  $X_{i,c}$  represents a vector of facility, resident, and staff characteristics for facility  $i$  and  $Z_c$  represent a vector of county-level characteristics where facility  $i$  is located.  $\gamma$  represents a state fixed effect and  $\varepsilon_{i,c}$  is a robust standard error term. All estimates are weighted by facility staff size (i.e., the denominator of the staff vaccination coverage calculation) with standard errors clustered at the facility level. Estimates from this model are presented in Figure 2 of the manuscript. Complete regression results are available from the authors upon request.

## eReferences

1. Centers for Medicare & Medicaid Services. COVID-19 Nursing Home Data. <https://data.cms.gov/stories/s/COVID-19-Nursing-Home-Data/bkwz-xpvg/>. Published 2020. Accessed June 18, 2020.
2. Centers for Disease Control and Prevention. Weekly COVID-19 Vaccination Data Reporting. Weekly HCP & Resident COVID-19 Vaccination Web site. <https://www.cdc.gov/nhsn/ltc/weekly-covid-vac/index.html>. Published 2021. Accessed May 24, 2021.
3. Centers for Medicare & Medicaid Services. Provider Info. Nursing Home Compare Data Web site. <https://data.cms.gov/provider-data/dataset/4pg5-n9py>. Published 2021. Accessed May 15, 2021.
4. Brown School of Public Health. LTCFocus. <http://ltcfocus.org/>. Published 2020. Accessed June 9, 2020.
5. Geng F, Stevenson DG, Grabowski DC. Daily Nursing Home Staffing Levels Highly Variable, Often Below CMS Expectations. *Health Affairs*. 2019;38(7):1095-1100.
6. Gandhi A, Hu Y, Grabowski DC. High Nursing Staff Turnover in Nursing Homes Offers Important Quality Information. *Health affairs (Project Hope)*. In press.
7. Centers for Disease Control and Prevention. Fully Vaccinated Adults as of 5/9/21. <https://data.cdc.gov/Vaccinations/Fully-Vaccinated-Adults/jm79-dz78>. Published 2021. Accessed May 15, 2021.
8. McGovern T. US County Level Election Results. [https://github.com/tonmcg/US\\_County\\_Level\\_Election\\_Results\\_08-20/commits?author=tonmcg](https://github.com/tonmcg/US_County_Level_Election_Results_08-20/commits?author=tonmcg). Published 2020. Accessed May 15, 2021.
9. Centers for Disease Control and Prevention. COVID-19 Vaccinations in the United States - County. <https://data.cdc.gov/Vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xkx-amqh>. Published 2021. Accessed July 22, 2021.